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MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

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MADROÑO

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OBSERVATIONS ON THE VEGETATION OF CHIHUAHUA

Forrest Shreve

The state of Chihuahua lies in the northwestern corner of the central table land of Mexico. Its location, size and physical features make it an area of importance in connection with the plant and animal geography of the southwestern United States, as well as in the investigation of the relations between the Sonoran and Chihuahuan deserts.

Knowledge of the flora of Chihuahua is based mainly upon collections made by some fourteen men,[1] and information regarding it is scattered through scores of publications over a period of sixty years. There is no check list or manual covering any part of the state. On the character and distribution of the vegetation only a few pages have been written and these with reference to the northern border. In many publications on other topics the plants have received occasional mention. Several men have mapped the vegetation of North America or of Mexico with little to guide them in reference to the Chihuahuan region. Knowledge of the fauna and ecological features of the animal life is in a very similar condition.

Brand (1) has published a map of the vegetation of northwestern Mexico, recognizing five types in Chihuahua. He makes no reference to the grassland and publishes no descriptions of the regions indicated on his map. In a later paper Brand (2) has described the land forms of the highlands of Chihuahua north of Ciudad Guerrero, with brief notes on the vegetation and some helpful illustrations and climatic tables.

The dearth of botanical information about Chihuahua has prompted the publication of the following brief sketch of the state, based on a trip made in the summer of 1937, on which all parts were visited except the oak forest and barrancas of the extreme southwestern corner. The writer was accompanied by Dr. L. R. Dice, of the University of Michigan, and Dr. T. D. Mallery, of the Desert Laboratory of the Carnegie Institution, to both of whom he is indebted for helpful discussion of the conditions encountered.

PHYSIOGRAPHY

Five rather clearly defined physiographic regions may be recognized in Chihuahua. These are the bajadas and low mountains of the northeast and east, the enclosed basins of the northwest and southeast, the elevated plains of the central district, the Sierra Madre Occidental, and the barrancas, or canyons of the Pacific slope of the Sierra Madre.

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[1] Wislizenius, Gregg, Schaffner, Wilkinson, Pringle, Palmer, Nelson, Rose, Hartman and Lloyd, Townsend and Barber, Hitchcock, and Le Seuer.

Madroño, vol. 5, pp. 1–48. January 17, 1939.

The Bajada Region. This part of the state borders the Rio Grande and the lower course of its only important Chihuahuan tributary, the Rio Conchos. The elevation varies from 800 to 1450 meters (2700 to 4750 feet). Gently falling bajadas and broad intermont plains occupy a high percentage of the region. Extensive limestone areas present the usual surface features of that material, being either hilly and broken or else rolling or nearly level, with little evidence of erosion and transport. The mountains of this region probably occupy from 5 per cent to 8 per cent of the total area.

The Enclosed Basin Region. The largest enclosed basins, or bolsons, lie in the north and the extreme southeast, at elevations from 1175 meters (3850 feet) in the former area to 1400 meters (4600 feet) in the latter. There are also numerous smaller basins in the midst of the Bajada Region as well as in the Elevated Plains Region. On the north three large lake beds, or playas, Laguna de Guzman, Laguna de Santa Maria and Laguna de Patos, receive the flood waters of rivers which drain the north end of the Elevated Plains Region. These rivers are fed by heavy summer rains and fall at a steep gradient, conditions which have enabled them to cut into the old deposits of mountain outwash and to carry sand through to their terminal playas. During the dry seasons water sometimes disappears from the lake beds and the deposits of sand are blown for distances of as much as 80 to 100 kilometers (50 to 60 miles). Part of northern Chihuahua is a vast dune complex and has a surface shaped almost wholly by the wind. The failure of the three contributaries of the largest playas to deliver their flood waters to the Rio Grande is apparently due to the accumulation of their loads between the playas and the Rio Grande.

The enclosed basins in the southeast, as well as the smaller ones in the central districts, are of structural origin. They are fed only by short streamways and floods from the torrential rains of the desert lowlands. Their playas are therefore built of fine alluvium rather than sand and have a high salt content. Under these conditions the action of the wind is confined to the daily agitation of the superficial alkaline dust through local spiral movements. Groups of white "tornillos" rise constantly during the daytime in slowly coiling columns to a height of 80 to 100 meters and circle majestically about the playa and its edges. The effects of wind are therefore slight, leaving the surface essentially as determined by the agency of water.

The drainage of extreme southeastern Chihuahua and the neighboring part of Coahuila runs into a large number of separate basins, which have either a central playa, if their catchment area is large, or a grass-covered floor, if their drainage area is small or wholly in the arid lowlands.

The Elevated Plains Region. This feature of Chihuahua forms a belt along the eastern base of the Sierra Madre which varies from 25 to 110 kilometers (15 to 65 miles) in width. Elevations in the Plains Region range from 1600 to 2100 meters (5250 to 7000 feet). Their surface is dotted with numerous small mountains and their eastern edge is supported by a series of barrier ranges which have a basal elevation about 600 meters (2000 feet) higher on the west than on the east. The Plains are composed of thoroughly disintegrated outwash material derived from the ancient degradation of the Sierra Madre. On the east the present level of the Plains is being effectively maintained by the barrier ranges. In the north, however, the surface is being attacked by the three rivers which feed the northern basins, and on the west the Rio Papigochíc, a tributary of the Yaqui, has eaten back into the Plains far east of the continental divide.

THE SIERRA MADRE REGION. The Sierra Madre Occidental lies in a north northwest-south southeast position and forms the continental divide, as well as the boundary between Chihuahua and Sonora. It consists of a broad series of ridges and mesas with summit elevations of 2500 to 2900 meters (8200 to 9500 feet), but at least three unexplored summits are believed to exceed 3500 meters (10,000 feet). The ridges are maturely worn and there are innumerable parks, meadows and flood plains with heavy accumulations of alluvium. There are large areas in the midst of which are no abrupt changes of elevation of more than 100 to 150 meters. The northernmost forested elevation is the Sierra de la Espejuela, 80 kilometers (50 miles) south of the International Boundary. With a single break at Carretas Pass, immediately south of this mountain, the Sierra Madre lies continuously above 2150 meters (7000 feet) for 800 kilometers (500 miles) to the south.

THE BARRANCA REGION. A small part of the Pacific slope of the Sierra Madre is comprised in this region, which lies partly in the states of Sonora and Sinaloa. Here are the evidences of the active cutting which has taken place since the last uplift of the Sierra Madre. Deep well-watered canyons with steep slopes have eaten far back into the mountains and in many places have isolated former portions of the Sierra or its subsidiary ranges. The Barranca Region is thus given an extremely irregular configuration and is confined to narrow bands and small areas. The fall from the western edge of the mature summit of the Sierra at 2150 meters (7000 feet) to the foothills of Sonora at 200 to 500 meters (650 to 1650 feet) takes place within a distance of 45 to 80 milometers (28 to 50 miles).

VEGETATION

The distribution of the types of vegetation which clothe Chihuahua is found to run closely parallel to that of the physiographic provinces which have just been described. On the accompanying map (text fig. 1) are shown the approximate boun-

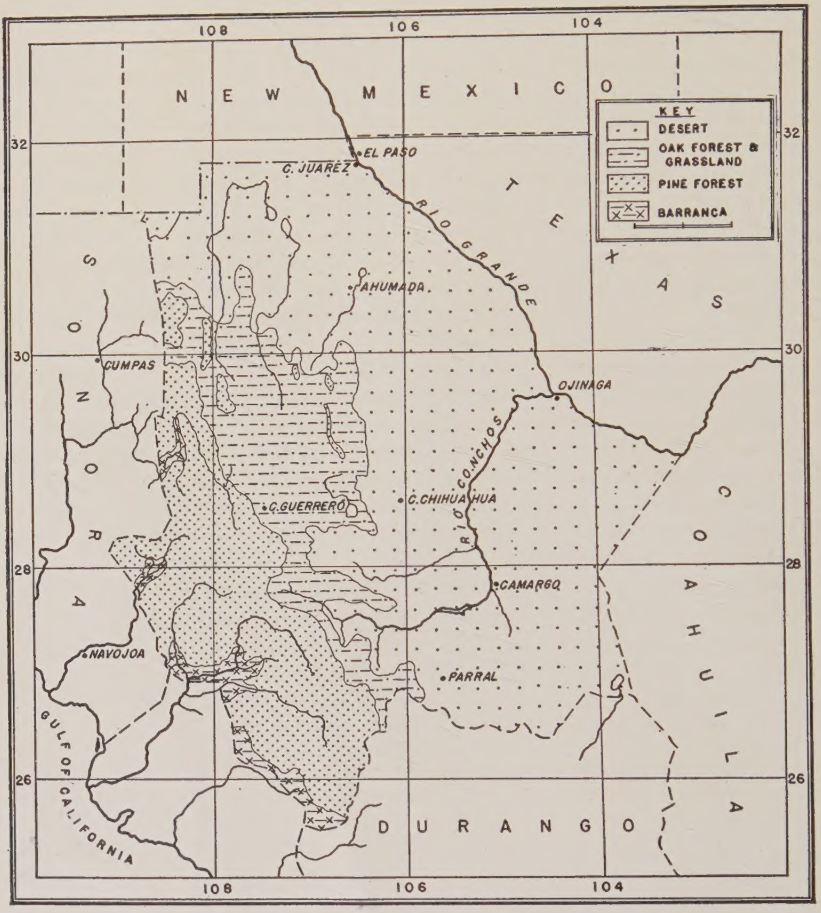

Fig. 1. Distribution of types of vegetation in Chihuahua.

daries of desert, coinciding with the Bajada Region and the Enclosed Basin Region; of grassland and oak forest, covering the Elevated Plains Region and the lesser mountains; of pine forest, clothing the Sierra Madre Region; and of oak and broadleaf forest filling the Barranca Region. These types of vegetation are clearly distinct except for the existence of intermediate areas between the desert and grassland and some intermingling of oaks and pines.

Desert. In the north and east Chihuahua is occupied by an unbroken stretch of desert which covers about 60 per cent of the state. It is a region of broad plains, long bajadas and large basins with widely spaced ranges of low mountains. There are many opportunities to travel for 150 to 300 kilometers (100 to

200 miles) without encountering substantial differences in the vegetation. Nevertheless there are marked differences between the widely separated parts of the area. The most distinct types of desert vegetation are those found in the sandy basins and dune region of the north, the bajadas and outwash plains of the northeast, the volcanic and limestone mountains of the northeast and east, the limestone plains of the south, and the bolsons of the southeast.

In the dune region a high percentage of the surface is wholly or partly stabilized but is covered by a very open stand of plants. There are local areas of the light cream colored sand which are in active movement, as well as numerous massive dunes almost wholly without plants. All of the features of dune development and plant succession which have been so adequately described by many workers are here exemplified on a large scale. The stabilized areas have a very open stand of *Prosopis glandulosa, Artemisia filifolia, Poliomintha incana, Ephedra Torreyana, Dalea scoparia, Hymenoclea monogyra, Atriplex canescens, Leiostemon Thurberi* and *Yucca elata.* Cacti are very uncommon and represented almost wholly by low platyopuntias. The most characteristic small perennials are:

Croton neomexicanus
Riddelia Cooperi
Heliotropium Greggii
Bahia absinthifolia
Sphaeralcea incana
Euphorbia Parryi
Coldenia hispidissima
Melampodium leucanthum
Sporobolus flexuosus
Wislizenia refracta
Palafoxia linearis

The bajadas and outwash plains occupy a larger area in Chihuahua than any other type of desert, covering the sector which lies between lines drawn north and east from Chihuahua City. Their vegetation is very uniform in physiognomy and very simple in composition. It is strongly dominated by *Larrea,* which is often nearly pure, or elsewhere associated with *Flourensia cernua* where the soil is thin or with *Prosopis glandulosa* where the soil is deep. In the lowest part of each basin or valley *Prosopis* is dominant as a shrub of 1 to 2 meters with its trunk buried and its branches radiating from a hummock of soil.

On the bajadas there are only a few large perennials associated with the three that have been mentioned, and none that are abundant. The important ones are:

Koeberlinia spinosa
Acacia Greggii
Condalia spathulata
Celtis pallida
Condalia lycioides
Opuntia macrocentra
Coldenia Greggii
Opuntia imbricata
Acacia vernicosa
Microrhamnus ericoides

On the higher parts of the bajadas, on the pediments surrounding the mountains and on the hills and mountain slopes the vegetation is much more diversified (pl. 1, fig. 1). *Larrea* loses its dominance although it does not disappear, and all of the associates just listed become more abundant. The most conspicuous plants are *Dasylirion Wheeleri, Fouquieria splendens, Opuntia imbricata* and the massive *Yucca macrocarpa.* The most abundant plants are *Agave Lechuguilla, Coldenia Greggii, Euphorbia antisyphilitica, Parthenium incanum* and *Jatropha spathulata.* The conspicuous plants are particularly abundant at the foot of mountain slopes and on the pediments. On gentler slopes, especially on limestone, the larger plants give way to the small but abundant ones. The only conspicuous cacti are *Opuntia imbricata,* reaching a height of 1 to 2 meters and *O. macrocentra,* which is here an erect plant but rarely exceeds 1 meter. Smaller cacti are, however, an important element in the vegetation, being chiefly represented by *Echinocactus horizonthalonius, Echinocereus dasyacanthus, E. stramineus, Coryphantha macromeris, Escobaria tuberculosa,* and *Thelocactus bicolor.*

Along the small drainageways of the desert there is a slight increase in density on the part of *Prosopis, Acacia, Celtis* and *Condalia spathulata,* but no considerable increase in height. Only along the largest arroyos are there any trees in the desert sense of woody plants with one or several trunks, branching from the ground level, and reaching a height of 5 to 6 meters. In addition to larger individuals of *Prosopis* will be found *Rhus choriophylla, Berberis trifoliata, Porlieria angustifolia, Chilopsis linearis, Celtis pallida,* and *Acacia paucispina.*

The enclosed basins, or bolsons, of southeastern Chihuahua are part of a large region of similar character which extends into the neighboring states of Coahuila and Durango. Here the mountains are low and very widely spaced and the drainage is shallow and vacillating. Nearly level plains from 30 to 80 kilometers (20 to 50 miles) in width present very uniform conditions. The elevation is from 1200 to 1500 meters (4000 to 5000 feet). The soil is light gray and of fine texture. The vegetation is low, sparse and monotonous. In the higher basins the floor is covered by pure stands of *Hilaria,* in the lower ones the dominant plants are *Larrea, Acacia vernicosa* and *Flourensia cernua,* constantly varying from place to place in their relative abundance. *Prosopis* and *Atriplex canescens* are also locally abundant as well as sparingly represented throughout the plains. Less common are *Celtis pallida, Condalia lycioides, Koeberlinia spinosa, Buddleia scordioides,* and *Lippia Wrightii.* Cacti are uncommon and represented only by *Opuntia Kleiniae, O. macrocentra, O. leptocaulis* and *Echinocereus conglomeratus.*

South of Saucillo the Rio Conchos and the Rio Florido form the western boundary of the bolson region. West of this boundary is a rolling limestone plain which extends south nearly as far as Parral and rises toward the west. The elevation of the

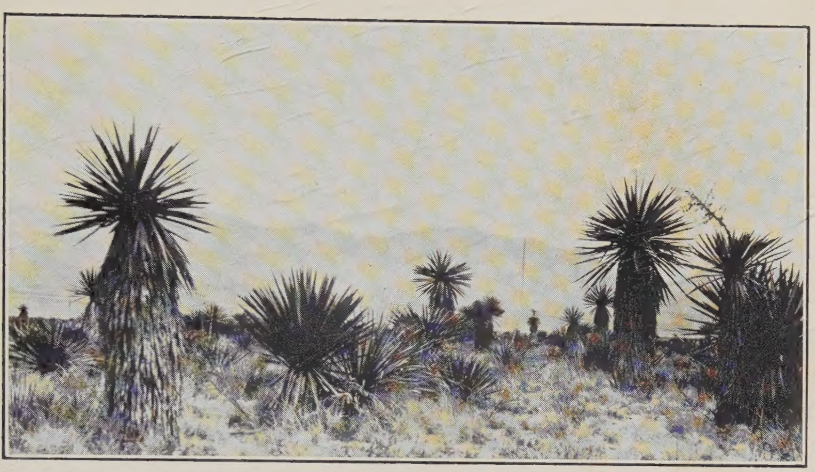

FIGURE 1

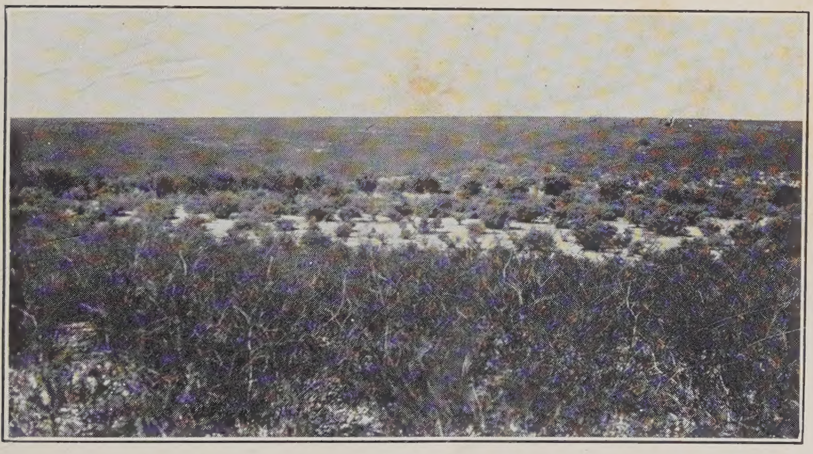

FIGURE 2

PLATE 1. VEGETATION OF CHIHUAHUA. Fig. 1. Vegetation on outwash slopes of Sierra Tasajera in northeastern Chihuahua at 1600 meters elevation: dominant plants, *Yucca macrocarpa, Dasylirion Wheeleri, Agave Lechuguilla, Coldenia Greggii, Lippia Wrightii* and *Hilaria mutica.* Fig. 2. Limestone plains west of Boquillas, in southern Chihuahua at 1400 meters elevation: vegetation a low closed stand of *Acacia vernicosa* and *Larrea tridentata.* In the depression: *Celtis reticulata, Condalia spathulata* and *Condalia lycioides.*

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plain varies from 1150 to 1375 meters (3800 to 4500 feet). The surface has both shallow and deeply cut drainageways, as well as many large and small depressions which have no surface outlet. The shallow drainageways and the large depressions have a deep clay soil which is commonly a very dark gray. A high percentage of the region has a soil which is very shallow or confined to irregular pockets in the surface of the limestone.

The vegetation of the thin soil of the limestone plains is a dense stand of shrubbery which rarely exceeds 1 meter in height (pl. 1, fig. 2). *Acacia vernicosa* is strongly dominant, with *Larrea* and *Flourensia* forming less than 15 per cent of the stand. Plants of secondary importance are few and infrequent, including:

Celtis pallida
Condalia spathulata
Agave Lechuguilla
Opuntia Engelmannii
Rhus microphylla
Leucophyllum laevigatum
Opuntia macrocentra
Koeberlinia spinosa

On the slightly deeper soil surrounding the depressions *Larrea* and *Flourensia* become more abundant than *Acacia vernicosa,* and nearly pure stands of *Flourensia* are frequently seen. In the depressions, which are in some cases from 10 to 15 kilometers in width, there are no shrubs and the prevailing vegetation is a very open sod of *Hilaria mutica.*

The western edge of the limestone plains was crossed at only one locality and the configuration of the area can not be stated. Without essential change of elevation the *Acacia* thickets give way on leaving the limestone, and at 1275 to 1375 meters (4200 to 4500 feet) on a deep loam soil a wholly different type of vegetation is encountered. This is a very open stand of grasses and root perennials with widely spaced shrubs 1.5 to 3 meters high. The three characteristic shrubs of the limestone, *Larrea, Flourensia* and *Acacia vernicosa,* are uncommon. The principal large shrubs are *Celtis pallida, Prosopis glutinosa, Condalia lycioides, Cassia Wislizeni, Tecoma Stans, Mimosa biuncifera* and *Ephedra antisyphilitica.* This is the uppermost type of desert vegetation and merges gradually into a desert-grassland transition similar to that which covers the plains of southern New Mexico. In Chihuahua the desert-grassland transition occupies the plains and bajadas which extend from Moctezuma on the north to the southern boundary of the state; lying above 1525 meters (5000 feet). It also covers the foothills and lower slopes of the barrier ranges, but the conditions there are diversified and the distribution of the vegetation is complex (pl. 2, fig. 1). Along streamways of mountain origin *Quercus Emoryi* descends to 1450 meters (4800 feet) and *Q. chihuahuensis* is sparingly represented on the slopes of the foothills at 1600 to 1775 meters (5250 to 5825 feet). Cacti and yuccas are uncommon but are seen much more frequently than in the upper edge of the desert. On ascending through the desert-grassland transition there is a gradual increase in the percentage of the surface covered by grasses, particularly on nearly level ground with soil 3 or 4 decimeters or more in depth. The elevation of the lower edge of the grassland is close to 1700 meters (5500 feet) at all localities visited.

Grassland. The grassland of Chihuahua resembles closely that of southeastern Arizona and southwestern New Mexico in its local distribution with respect to topography, in physiognomy, in its dominant grasses and to some extent in the associated non-gramineous plants (pl. 2, fig. 2). At all elevations the prevailing grasses are species of *Bouteloua* (*B. gracilis, B. hirsuta, B. radicosa, B. chondrosioides*); which serve to give a striking uniformity to the texture of the plant covering over large areas. In certain places taller grasses form bunches scattered over the sod of *Bouteloua.*

In many parts of the desert-grassland transition there is evidence that grazing has altered the natural vegetation, with a reduction in the amount of grass and an increase in the native weeds *Gutierrezia, Aplopappus* and *Verbesina.* Above 1700 meters (5500 feet), however, the continuity of the grass cover, the absence of gullying and excessive erosion, and the scarcity of unpalatable weeds indicates that the vegetation is in a condition close to the natural one. Although the higher grasslands are grazed, it appears obvious that the drain upon them has been light enough for the maintenance of a good self-perpetuating cover under the existing rainfall conditions.

On the upper margins of the grassland valleys a very open oak forest has, in many places, been superposed on the grassland, with little modification of the composition of the grassland except in the shade of the oaks. In such situations a few shrubs are found, being species of more abundant occurrence at somewhat higher elevations. Where extrusions of lava or dykes of other rock occur in the grassland and now lie nearly at accordant level with the surface of the outwash material surrounding them, there is a light and broken cover of grasses (*Andropogon barbinodis, A. hirtiflorus, Eragrostis mexicana, Aristida adscensionis, A. divaricata, Muhlenbergia Emersleyi, Oryzopsis fimbriata*). In such situations there is commonly a very open stand of woody perennials, including stunted individuals of *Quercus Emoryi, Q. santaclarensis, Juniperus mexicana, Mimosa biuncifera, Cowania Stansburiana* and *Mimosa dysocarpa.*

When the grassland region is considered as a whole the total number of root perennials associated with the grasses is large. The presence of a particular group of species in a given spot appears to be determined to some extent by the texture and prevailing moisture of the soil, and to a very considerable degree by the chances of seed dispersal and other more obscure conditions. Certain of the associated perennials

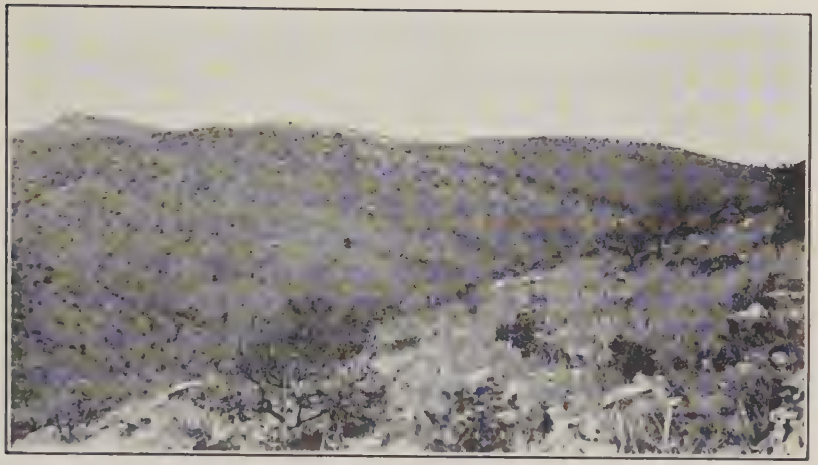

FIGURE 1

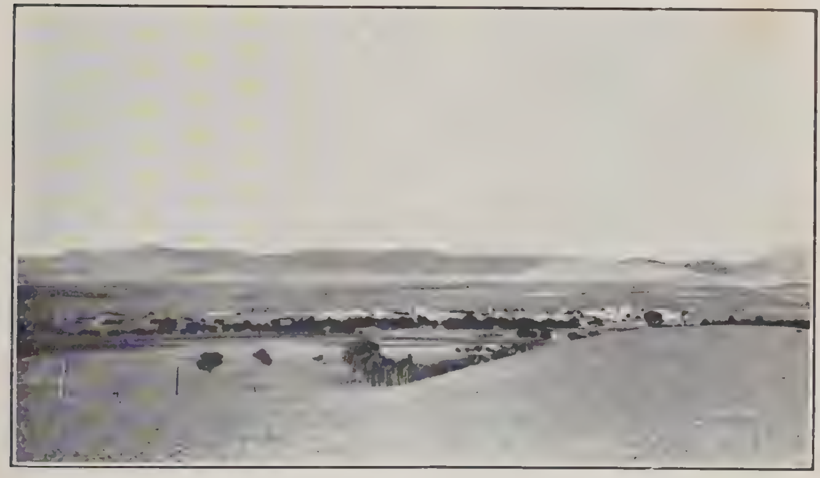

FIGURE 2

PLATE 2. VEGETATION OF CHIHUAHUA. Fig. 1. Hills west of Santa Isabel in desert-grassland transition at 1700 meters elevation. The tree is *Quercus chihuahuensis*. Fig. 2. Looking east across grassland in upper drainage of Rio Papigochíc at San Isidro in western Chihuahua at 2100 meters elevation.

are of general occurrence while others are abundant in areas of 1, 10 or 100 hectares and rarely seen elsewhere. Many of the perennials are prostrate in habit or low in their mature height, while a number of others reach a height of 6 to 8 decimeters at the time of flowering. About half of the tall species are slender and have leaves either so small in size or so few in number that the plants are inconspicuous. Very few native annuals are found in the region. The great majority of the herbaceous perennials have enlarged roots or rhizomes. The number of species and individuals of bulbous plants is much greater than in the grasslands of Arizona and New Mexico.

The following grassland associates are low or prostrate plants little exceeding the turf of grasses in height:

Brayulinea densa
Houstonia Wrightii
Dyschoriste decumbens
Plantago mexicana
Calliandra humilis
Potentilla Mexiae
Phlox mesoleuca
Helianthemum glomeratum
Tragia nepetifolia
Acalypha Lindheimeri
Verbena canescens
Vincetoxicum nummularium
Sisyrinchium tenuifolium
Nothoscordum fragrans
Oenothera serrulata

The taller perennials of the grassland include:

Hymenopappus mexicanus
Petalostemon oligophyllum
Thelesperma gracile
Dalea Grayi
Tagetes lucida
Lithospermum cobrense
Linum australe
Scutellaria sp.
Eryngium Wrightii
Castilleia mexicana
Lupinus Shrevei
Gaura gracilis
Erigeron divergens
Ratibida columnaris

Some of the grasses and many of the herbaceous perennials of the grassland are found in the oak forest and even in the lower and more open parts of the pine forest. The upper edge of the grassland is determined by the fact that there is no soil above 2200 meters (7200 feet) which is rock-free, level and not extremely moist.

Oak Forest (Encinal). The oak forest of Chihuahua is found through nearly the same range of altitude as the grassland, which indicates that the climatic requirements of the two are closely similar. The oaks of lowest range, *Quercus Emoryi* and *Q. chihuahuensis,* descend locally into the upper edge of the desert-grassland transition. The oaks of highest range, *Q. hypoleuca, Q. pennivenia, Q. Sipuraca* and *Q. epileuca,* are associated with the pines at 2150 to 2300 meters (7000 to 7550 feet) and become minor constituents of the pine forest above that elevation.

The distribution of oak forest and grassland throughout their common range of altitude is determined by soil conditions, as already indicated. Below 2000 meters (6560 feet) the oak forest is very open and many of the trees are small. On the eastern edge of the grassland plateau there are ridges and hills of 2150 meters (7000 feet) with very poor stands of *Quercus Emoryi,* but at the same elevation nearer the base of the Sierra Madre the stands are heavier and the trees are larger. The finest groves of oaks, below the elevations at which they mingle with the pines, are on the coarse soil of broad flood plains, bordering streams that have just emerged from mountain canyons at 2000 to 2150 meters (6560 to 7000 feet). Rarely are such groves dense enough for the full grown trees to shade more than half of the surface of the ground. On stony, level soil with poorer moisture conditions there are dense thickets of small oaks. On the hills and low mountain ranges that interrupt the continuity of the great grassland valleys the most abundant oaks are *Quercus Emoryi, Q. santaclarensis, Q. chuichupensis* and *Q. hypoleuca.* Other oaks occurring locally or in very scattered stands are *Quercus chihuahuensis, Q. arizonica* and *Q. durangensis. Juniperus mexicana* and *Pinus cembroides* often occur with the oaks and on arid ridges outnumber them.

In the latter part of July 1937 all of the species of oak were in leaf in favorable localities. The foliage of *Quercus santaclarensis* and *Q. chuichupensis* appeared to be young at that time, indicating that these species are deciduous. On some of the small ranges of hills well to the east of the Sierra Madre the dominant oaks are *Q. santaclarensis* and the evergreen *Q. Emoryi,* both of which were conspicuously bare of foliage. This condition was probably due to the unusually late commencement of the summer rains in 1937.

Many grasses and a large number of shrubby and herbaceous perennials are characteristic of the oak forest. Fully one-fourth of the number are equally abundant in the grassland. The presence of many of the others is favored by the shade of the oaks, but a far larger number are present as a result of the stony surface and diversified soil structure and are to be found outside the shade of the oaks.

The most abundant shrubs and herbaceous perennials in the oak forest are:

Rhus trilobata (shrub)
Ceanothus buxifolius "
Mimosa dysocarpa "
Cowania Stansburiana "
Rhamnus pinetorum "
Bouvardia triphylla "
Houstonia Wrightii
Erigeron divergens
Gnaphalium chilense
Cyperus seslerioides

Cologania Lemmoni
Muhlenbergia gracilis
Tradescantia pinetorum
Dyschoriste decumbens
Penstemon pulchellus
Thalictrum pinnatum
Lithospermum cobrense
Cologania longifolia
Eriogonum atrorubens
Ipomoea costellata

Indigofera ornithopodioides
Tradescantia crassifolia
Eragrostis mexicana
Phaseolus Metcalfei
Ipomoea madrensis
Oxalis albicans
Tephrosia leucantha
Helianthemum glomeratum
Stipa Pringlei
Bidens heterosperma
Geranium niveum
Hymenopappus mexicanus
Drymaria tenella
Desmodium neomexicanum (annual)
Schkuhria Pringlei “
Crotalaria sagittalis “

Pine Forest. On the eastern slopes of the Sierra Madre the lower edge of the pine forest is approximately at 2150 meters (7000 feet) elevation but in the valleys draining into the Pacific it descends to 1800 meters (5900 feet), while open stands mingled with oaks occur below 1525 meters (5000 feet). About 18 per cent of the area of Chihuahua is blanketed by a nearly continuous forest of pines, more than half of which is in the Pacific drainage.

Like all other great mountain ranges the Sierra Madre presents a wide diversity of habitat conditions, with its stony ridges, gentle slopes, parks, meadows and constant streams. In general aspect the pine forest and its accompanying communities of plants resemble the mountain forests of Arizona and New Mexico. The varying density of the stands of pine, the fringe of broad-leaved trees along the water courses, the thickets of *Populus tremuloides* on the cool slopes, or of shrubby oaks and *Arctostaphylos pungens* on the sunny ones, the parks, meadows and streambed gravel all bear vegetation with the familiar physiognomy of the north (pl. 3, figs. 1, 2). The similarity is found to be due to plants of the same genera, or the same life forms, very many of which belong to species not found north of Chihuahua. Many trees, a few shrubs and a large number of aquatic and palustrine plants are common to the pine forests of the southwestern states.

The number of species of trees found above 2150 meters (7000 feet) is not large. On the lower edge of the pine forest and in its outlying areas *Pinus apacheca* and *P. chihuahuana* are the dominant trees, with *P. cembroides* in the least favorable situations. The principal pine on the highest ridges and slopes is *Pinus arizonica.* On the Pacific slopes the dominance is held in some valleys by *P. Lumholtzii* and in others by *P. ayacahuite.* The only other abundant conifers are *Pseudotsuga mucronata, Pinus pinceana, P. strobiformis, Cupressus arizonica* and *Juniperus mexicana.* Other trees of scattered occurrence or of distinctive habitat requirements are:

Quercus pennivenia
Alnus acuminata
Populus tremuloides
Quercus epileuca
Quercus durifolia
Quercus diversicolor
Arbutus xalapensis
Quercus incarnata

In small shrubs and herbaceous perennials the flora of the pine forest of the Sierra Madre is extremely rich. Not only new species but many new genera confront the visitor from the north. The Leguminosae and Compositae are very richly represented by plants of both wet and dry situations. Many of the important genera of mountain plants of the western United States are present here, as *Rubus, Potentilla, Penstemon, Lithospermum, Erigeron, Gnaphalium, Ranunculus, Stellaria, Dalea* and *Desmodium*. A large number of genera are either endemic to the Sierra Madre or else find their northern limits in the forests of Chihuahua. Affinity with the characteristic elements of the flora of the Sierra Madre is found in the United States only in the Chiricahua, Huachuca, Santa Catalina and adjacent mountains of southern Arizona.

The number of collectors who have penetrated the Sierra Madre is small and the percentage of new species found in the most recent collections indicates that the wealth of its flora can not yet be estimated. The distribution of many of the commonest plants is very poorly known, and the character, distribution and composition of the plant communities remain uninvestigated.

Barranca Forest. The writer has seen nothing of the higher elevations of the Barranca Region in Chihuahua and only a few areas on its lower edge in Sonora. Lumholtz (4) gave some brief descriptions of this vegetation in the narrative of his expedition across the Sierra Madre from Granados, Sonora, to Casas Grandes, Chihuahua, through the valley of Rio Bavispe. Hovey (3) published a few botanical observations made on a geological excursion from Minaca to Dolores, in the drainage of Rio Aros, a tributary of Rio Yaqui. The forest in the valley of Rio Mayo and its tributaries has been explored recently by Gentry, and the writer is indebted to him for an opportunity to examine the manuscript of a paper which he is preparing on the flora and vegetation of that region.

Knowledge of the barranca forest is nevertheless sufficient to indicate that it is one of the distinctive vegetational regions of Chihuahua. The collections made by Gentry in the Mayo Valley give ample evidence of the richness and sub-tropical affinities of the flora.

Summary

Chihuahua occupies the eastern slope of the continental divide immediately south of the Rio Grande. The surface of the state is highly diversified in elevation and physiographic development. The distribution of the types of vegetation conforms closely to the physiographic provinces. The broad detrital valleys, with their pediments, low mountain ranges and enclosed basins, are occupied by desert. The elevated plains and their included mountains are occupied by grassland where the soil is deep and nearly level and by evergreen oak forest on mountain slopes or

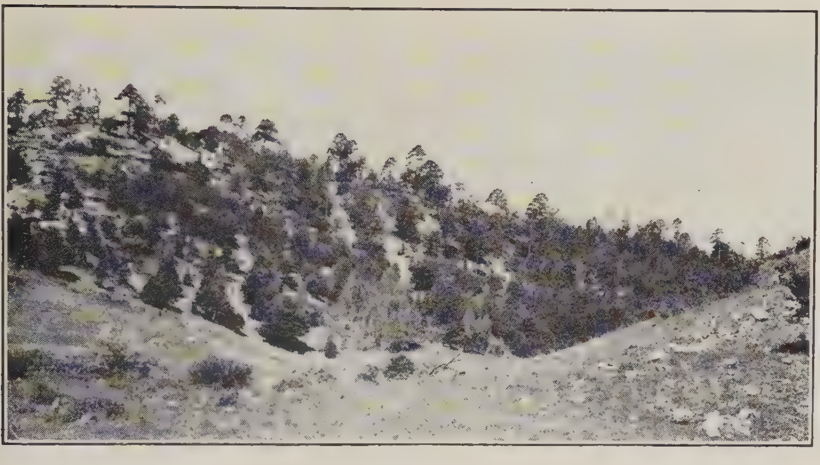

FIGURE 1

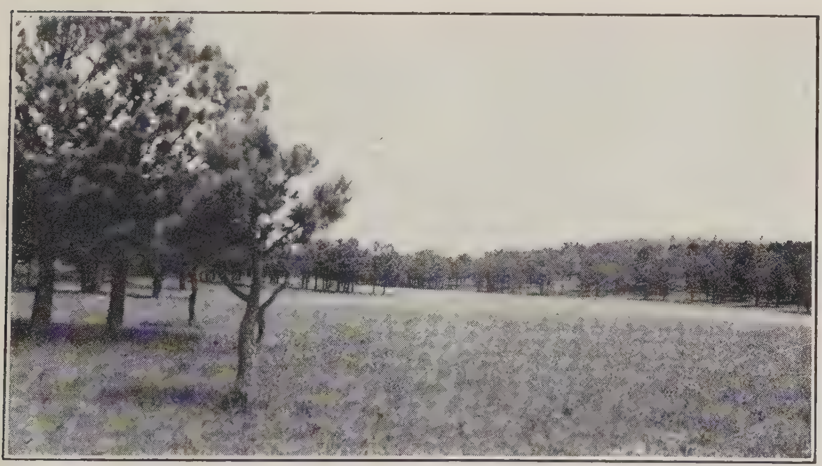

FIGURE 2

PLATE 3. VEGETATION OF CHIHUAHUA. Fig. 1. Mountain slopes twelve kilometers north of San Juanito in southwestern Chihuahua at 2400 meters elevation. The open forest of *Pinus arizonica, Pinus apacheca,* and *Populus tremuloides* faces a slope covered by a thicket of *Quercus bocoyensis.* Fig. 2. Park in pine forest near San Juanito at 2500 meters elevation with grasses, *Ranunculus pentodontus* and *Achaetogeron affinis.*

shallow soil. The slopes and summits of the Sierra Madre Occidental are covered by forest in which several species of pine are dominant. The narrow canyons on the Pacific slopes of the Sierra Madre are occupied by a forest of evergreen oaks and other evergreen or deciduous broad-leaved trees. In their physiognomy the types of vegetation resemble those of southeastern Arizona and southwestern New Mexico. The flora of northern Chihuahua is very similar to that of the adjacent parts of New Mexico and Texas, but in each of the types of vegetation there is a strong infusion of endemic or southern species not found in the United States.

Desert Laboratory,
Carnegie Institution of Washington,
Tucson, Arizona, July, 1938.

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NOTES ON THE GENUS CEANOTHUS IN CALIFORNIA

H. E. MCMINN

In several genera of California shrubs such as *Rhamnus, Ceanothus, Baccharis* and *Arctostaphylos,* there are species which vary in their habit of growth from tall and erect to low, spreading, decumbent, or prostrate. The low-growing forms of some of these species are very desirable as ornamentals, especially as ground-covers. In some instances there is at present little evidence for the separation taxonomically of the prostrate, decumbent, and sprawling forms from the erect forms. In others, however, where observations on transplants have been made it seems clear that the low growth-forms which usually inhabit coastal bluffs and adjacent wind-swept mountains are genetically distinct from the erect plants which grow farther inland or away from the effects of the winds from the ocean. One of these forms having retained its low-growing habit in cultivation for over three years is here described as a new variety.

CEANOTHUS PAPILLOSUS var. **Roweanus** var. nov. Frutex compactus, sempervirens, 3–9 dm. altus (vel inter alios frutices), usque ad 1.5 m. in latitudine 1.2–2 m.; ramis arcuatis, ramulis aliquanto horizontalibus; foliis anguste oblongis vel linearibus, 1.2–4.5 cm. longis, 2–8 mm. latis, pinnate nervatis, supra atroviridibus, glabris, dense glanduloso-papillatis, subtus dense lanato-papillatis, marginibus revolutis et glanduloso-papillatis, sessilibus vel brevipetiolatis; flores fructusque ut ei apud speciem.

Compact evergreen shrub, 3 to 9 dm. high (or up to 1.5 m. in competition with other shrubs) and with a spread of 1.2 to 2 m.; branches arched and in somewhat horizontal sprays; leaves narrowly oblong or linear, 1.2 to 4.5 cm. long, 2 to 8 mm. wide, pinnately veined, upper surface dark green, glabrous, densely glandular-papillate, lower surface densely woolly-hirsute, the margins revolute and glandular-papillate, sessile or short-petiolate; flowers and fruit as in the species.

Type. Summit of Mount Tranquillon, northwestern Santa Barbara County, California, altitude 2250 feet, March 27, 1938, *M. Van Rensselaer 450* (University of California Herbarium no. 600030). Capsules were collected at the same locality by E. D. Rowe July 7, 1938.

This variety, to my knowledge, occurs only in a small area in the vicinity of the type locality. Its spreading habit, compact branching, dark green papillate leaves, and dark blue flowers borne in great profusion make it a most desirable ornamental. Specimens which have been in cultivation for over three years at La Purisima Mission Gardens and at the Blaksley Botanic Garden have retained the low spreading habit whereas transplanted specimens and plants grown from seeds of *Ceanothus papillosus* Torr. & Gray taken from the Santa Cruz Mountains have maintained the erect habit of growth.

I take pleasure in naming this variety in honor of Mr. E. D. Rowe, who first called it to the attention of botanists in 1935. Mr. Rowe, now in charge of the planting at La Purisima Mission, has been in landscape gardening work in Santa Barbara for the past thirty years and has done much to foster an interest in a wide use of native shrubs as ornamentals.

For the past ten years I have been interested in studying the distributional range of another group of *Ceanothi* which have been variously referred to *Ceanothus cuneatus* Nutt., *C. rigidus* Nutt., or *C. cuneatus* var. *ramulosus* Greene. These shrubs occur in dry rocky or more usually in sandy situations in the Coast Ranges from Santa Barbara County (La Purisima Hills and Burton Mesa, near Lompoc) northward to southern Monterey County and in Santa Cruz and Marin counties. Around Monterey Bay they are replaced by *C. rigidus* Nutt. Since these plants are intermediate between *C. cuneatus* and *C. rigidus* and are not associated geographically with either species it seems best for the time being to consider them as specifically distinct. An emended description follows.

Ceanothus ramulosus (Greene) McMinn comb. nov. *C. cuneatus* var. *ramulosus* Greene, Fl. Fran., 86. 1891. Coast Ceanothus.

Shrub, 6 to 12 dm. high; branches spreading or arching, or sometimes procumbent; leaves opposite and evergreen, usually not crowded on the branchlets; the blades variable in shape but typically obovate to oblanceolate, sometimes nearly round, 6 to 20 mm. long, 3 to 9 mm. wide, light to dark green above, paler beneath, usually toothed near the truncate or rounded apex, often entire, nearly sessile; flowers lavender, blue, or nearly white, in small peduncled umbels; fruit globose, about 5 mm. in diameter, varying from prominently 3-horned to nearly hornless. February to April.

On the bluffs above Point Sal, Santa Barbara County, this species is procumbent to nearly prostrate. On Burton Mesa and on La Purisima Hills, Santa Barbara County, the plants have dark compact foliage and in this character they resemble plants of *C. rigidus* more closely than those of *C. cuneatus.* The leaves are often cuneate-oblong and the fruits are often nearly hornless. Plants from seeds collected in Marin County and grown in our trial garden with *C. rigidus* and *C. cuneatus* show the distinct long-arching type of branches and pale blue or lavender flowers characteristic of the parent plant.

Mills College, California,
November 18, 1938.

TWO MEXICAN SPECIES OF HYPTIS

Carl Epling

Amongst a recent shipment of Mexican Labiatae collected by Mr. George C. Hinton in the states of Guerrero and Mexico are two undescribed species of *Hyptis.* Both are referable to the section *Buddleioides* subsection *Umbellatae.* As judged from the herbarium specimens both are lovely.

Hyptis perpulcher sp. nov. per specim. in Mexico prov. Temascaltepec ad Pungarancho in colle a Hinton (no. 8574) lectum constituta est; typum in herb. Univ. Calif. (Los Angeles), isotypum in herb. Kew. vidi.

Herba suffruticosa fragrantissima perpulcher ut videtur caulibus ad 4 m. altis solum superne inter flores visis purpureis glaucis ramulis superne hirtellis; foliorum laminis cordatis 12–15 cm. diametro (? et ultra) petiolis 5 cm. longis elatis, in apice acuminatis, marginibus irregulariter crenato-serratis, paginis ambobus glabris solum subtus ad venas obscure hirtellis; floribus numerosis parvis in umbellis purpureis pedunculis .5–1 cm. longis elatis bracteis parvis linearibus subtentis in paniculis speciosis gracillimis dispositis, pedicellis maturis filiformibus 7–8 mm. longis superne incrassatis elatis; calycibus florentibus anguste turbinatis 3 mm. longis extus dense purpureo-pubescentibus, dentibus deltoideis circiter .5 mm. longis, in maturitate tubo 7.5 mm. longo subcylindrato dentibus vix mutatis conniventibus; corollarum caerulearum tubo 2.5 mm. longo.

Mexico: Mexico; Temascaltepec; ad Pungarancho in colle.

Hyptis iodantha sp. nov. per specim. in Mexico prov. Guerrero in regione Mina prope Zapo in colle a Hinton (no. 9844) lectum constituta est; typum in herb. Univ. Calif. (Los Angeles), isotypum in herb. Kew. vidi.

Frutex pulcher altitudine ad 3 m. ramulis villosis et inter flores hirtellis; foliorum laminis ovato-lanceolatis 12–15 cm. longis 5–7 cm. latis supra medium longe acuminatis in basi cordatis, petiolis 1–2 cm. longis elatis, marginibus irregulariter crenato-serratis pagina superiore hirtella inferiore incano-tomentosa molle; floribus numerosis in umbellis purpureis pedunculis 1–2 mm. longis elatis bracteis minutis subtentis in paniculis divaricato-ramosis 20–25 cm. altis dispositis pedicellis maturis filiformibus 5 mm. longis superne incrassatis elatis; calycibus florentibus turbinatis 2.5 mm. longis extus dense purpureo-pubescentibus, dentibus deltoideis vix .5 mm. altis in maturitate conniventibus in maturitate tubo 4.5 mm. longo subcylindrato; corollarum violacearum tubo 2.5 mm. longo.

Mexico: Guerrero; Mina; Zapo in colle.

University of California at
Los Angeles, April 20, 1938.

THE VIOLETS OF COLORADO

Alice Marial Spotts

The genus *Viola* is a characteristic although a minor element of the flora of Colorado. *Viola Nuttallii,* a yellow-flowered perennial with lanceolate leaves, and *V. Rafinesquii,* a small blue-flowered annual, both of which flower in April and May, are frequent on the eastern plains and the lower foothills. In shady canyons, at lower altitudes, the long-stemmed white-flowered *V. rugulosa* and *V. canadensis* are important. Montane species are nowhere common.

Since the "New Manual of Rocky Mountain Botany" (1909) by Coulter and Nelson is now thirty years old, and "The Flora of Colorado" (1906) and "Flora of the Rocky Mountains and Adjacent Plains" (1917) by Rydberg are both out of print it seems desirable to prepare a re-description of the species of violets of Colorado. The descriptions have been drawn from herbarium specimens and from the writer's field observations during two seasons. The University of Colorado specimens of early collection, which were identified by Ezra Brainerd, formed a valuable beginning for the present study.

In the "Flora of Colorado," Rydberg lists fourteen species and three varieties of violets for the state. Brainerd in Rydberg's "Flora of the Rocky Mountains and Adjacent Plains" credits Colorado with twenty-one species and one variety. In Brainerd's later work, "Violets of North America" (Bull. Vermont Agri. Exp. Sta. no. 224. 1921) fourteen species are listed for Colorado. The present paper describes eighteen species and mentions three subspecies and one variety. The nomenclature here followed is that of Brainerd's treatment in the "Flora of the Rocky Mountains and Adjacent Plains" with the following exceptions: *Viola montanensis* Rydb. is not considered distinct from *V. adunca* J. E. Smith (thus agreeing with Brainerd's later treatment); *V. scopulorum* (Gray) Greene is not considered a distinct species but a variety of *V. canadensis* L.

Grateful acknowledgement is made to Dr. Aven Nelson of the University of Wyoming and to Professor Ernest C. Smith of Colorado State College of Agriculture for loan of material, also to Professor C. L. Porter of the University of Wyoming for his examination and report upon a number of specimens. The writer is indebted to Dr. Francis Ramaley of the University of Colorado for helpful suggestions during the work and for his examination of herbarium specimens at the Missouri Botanical Gardens, University of Illinois, and Ohio State University. The writer is also indebted to the curators of the above mentioned herbaria. Mr. Joseph Ewan of the University of Colorado has given valuable advice concerning the manuscript.

In the field, the different species of violets may be recognized chiefly by flower color and habit of growth, but in dried specimens the color is often faded and growth habit is not always easy of determination. The key given in this study utilizes as a primary segregating character the presence or absence of evident stems above ground and as a secondary division leaf outline and flower color. The presence or absence of stolons is difficult to use in a key since many specimens are collected before the stolons have developed. Violet plants may be glabrous, subglabrous or pubescent, yet pubescence is such a variable character that it is not advisable to rely too much upon it in the segregation of species. The length and outline of the spur is often useful in the identification of a species. The shapes of style and stigma vary in different species but are often distorted by drying. Cleistogamy is frequent among violets, the late summer or early autumn cleistogamous flowers bearing an abundance of seeds. The characters of the cleistogamous flowers may be of taxonomic value but cannot always be made use of since herbarium specimens are often collected at a time when the plants are producing only petaliferous flowers. Fruit and seed characters are often valuable and are used in the specific descriptions in this paper.

Most of the violets occurring in Colorado are widely distributed, about half of the species ranging chiefly to the east and the other half chiefly to the west as far as the Pacific Coast states. One variety and three subspecies are confined to the Rocky Mountain region: *Viola canadensis* var. *scopulorum* Gray, *V. adunca* subsp. *radicosa* Baker, *V. adunca* subsp. *Ashtonae* Baker, *V. palustris* subsp. *brevipes* Baker. *Viola linguaefolia* occurs both in the Rocky Mountain area and in the Pacific Coast states and *V. biflora* is found in the Rocky Mountains and in Alaska. Most of the species are rare or local in the state. Only the following are at all common or even frequent: *V. Nuttallii, V. Rafinesquii, V. rugulosa, V. canadensis, V. nephrophylla, V. adunca, V. bellidifolia.*

More species of violets occur in the submontane and montane life zones than in the plains area or in the higher zones; many more grow in moist places than in dry situations. Some of the species are confined to one or two life zones, while others occur in at least three zones. The altitudes indicated in the following tabulation are approximate as they vary in different parts of the state:

- Plants of plains and lower foothills, from 4000 to 6000 feet.
  - Fields, hillsides or forest openings . . . *V. pedatifida, V. pratincola, V. Rafinesquii.*
  - Moist woods or streamsides . . . *V. canadensis, V. nephrophylla, V. retusa, V. vallicola.*
- Plants submontane, from 6000 to 8000 feet.
  - Forest openings or hillsides . . . *V. Nuttallii, V. pedatifida, V. pratincola, V. venosa.*
  - Moist woods or streamsides . . . *V. adunca, V. canadensis, V. nephrophylla, V. linguaefolia, V. retusa, V. rugulosa, V. Selkirkii, V. vallicola.*
- Plants montane, from 8000 to 10,000 feet.
  - Moist shaded situations . . . *V. adunca, V. bellidifolia, V. canadensis, V. linguaefolia, V. renifolia, V. rugulosa, V. Selkirkii.*
  - Bogs, streambanks or wet meadows . . . *V. biflora, V. palustris.*
  - Rocky hillsides . . . *V. Sheltonii.*
- Plants subalpine and alpine, above 10,000 feet.
  - Stream banks or moist ground . . . *V. bellidifolia, V. biflora, V. renifolia.*

Key to Colorado Species of Viola

Plants acaulescent (*V. palustris* stoloniferous); flowers borne singly on a scape; petals violet or white, never yellow.

- Leaves 2–3 ternately parted, minutely pubescent .... 1. *V. pedatifida*
- Leaves entire, glabrous or hirtellous.
  - Flowers white, with purple veins.
    - Leaves cordate; plants of bogs and wet meadows, plants stoloniferous .... 4a. *V. palustris* subsp. *brevipes*
    - Leaves reniform; woodland plants .... 2. *V. renifolia*
  - Flowers violet, or lilac.
    - Rootstocks slender; length of petals usually under 10 mm.

Leaves hirtellous on upper surface; spur long, enlarged and rounded at base .... 3. *V. Selkirkii*
Leaves glabrous throughout; spur short and thick, plants stoloniferous .... 4. *V. palustris*
Rootstocks thick; length of petals usually more than 10 mm.
Spurred petal glabrous, rounded at apex; leaves subacute or abruptly pointed...... 5. *V. pratincola*
Spurred petal bearded, emarginate or retuse; leaves obtuse to acuminate.
Mature leaves obtuse; spurred petal thickly bearded; sepals obtuse .... 6. *V. nephrophylla*
Mature leaves often abruptly acuminate; spurred petal slightly hairy; sepals acute .... 7. *V. retusa*
Plants caulescent; flowers axillary; petals pale bluish-violet, violet, white, or yellow.
Annuals; stipules large, leaf-like, palmately pinnatifid or laciniate; petals pale bluish-violet............. 8. *V. Rafinesquii*
Perennials; stipules small, entire or spinulose-serrate.
Leaves divided; flowers pale yellow .... 9. *V. Sheltonii*
Leaves entire, denticulate, or shallowly lobed.
Flowers yellow, often tinged on the back with purple or brown.
First peduncles from axils of upper leaves; leaves cordate-reniform .... 10. *V. biflora*
First peduncles arising from near base of plant; leaves various.
Plant erect; basal leaves 4–9 cm. long, oblong-lanceolate to ovate .... 11. *V. linguaefolia*
Plant ascending or widely spreading to prostrate; basal leaves 2–7 cm. long, of various shapes.
Plant usually dwarf; peduncles seldom 8 cm.; upper leaf-blades less than 2 cm., 3-lobed, hastate .... 12. *V. venosa*
Plant larger; all leaves entire, denticulate, or dentate, never hastate.
Leaves linear-lanceolate, subacute, the base tapering into the petiole .... 13. *V. Nuttallii*
Leaves truncate to subcordate, obtuse.. 14. *V. vallicola*
Flowers violet, or nearly white with purple veins.
Flowers violet; stipules spinulose, serrate, or toothed.
Plant dwarf, glabrous; stem short and obscure .... 15. *V. bellidifolia*
Plant generally more than 5 cm. tall, puberulent throughout or glabrous; stems numerous .... 16. *V. adunca*
Flowers white, purple veined, with yellow base, purple on back; stipules entire, mostly scarious.
Leaves hirsutulous beneath, the root leaves from broadly cordate to reniform; plants stoloniferous .... 17. *V. rugulosa*
Leaves subglabrous, the root leaves cordate ovate; stolons not present .... 18. *V. canadensis*

1. **Viola pedatifida** Don, Gard. Dict. 1: 320. 1831. *V. delphinifolia* Nutt. in Torr. & Gray, Fl. N. Amer. 1: 136. 1838. Prairie Violet.

Rootstock ascending; plant without stolons, acaulescent, 7–20 cm. high, minutely pubescent or almost glabrous; leaf blades 1–7 cm. long, 2–8 cm. wide, 2–3 parted, divisions ternately cleft and incised into linear, obtuse, entire or lobed segments, usually truncate or cuneate at the base, margins and mid-rib hirsutulous; petioles 3–13 cm. long; stipules ovate-lanceolate, acuminate; petals violet, obovate, 10–20 mm. long, half as wide, lateral petals bearded; spur short; sepals linear or lanceolate, acute or obtuse, 6–10 mm. long, 1–3 mm. wide, margins hirsutulous; peduncles of petaliferous flowers taller than the leaves, of apetaliferous flowers shorter, but erect; cleistogamous capsule light gray when ripe, glabrous, 10–15 mm. long; seeds light brown, 2 mm. long.

From Ohio northwest through Wisconsin and Minnesota to Alberta, southwest through the prairie and Rocky Mountain states to New Mexico and Arizona. Colorado: moist grassland forest openings, 5,000 to 10,000 feet; infrequent. April–June.

2. Viola renifolia Gray, Proc. Amer. Acad. 8: 288. 1870. *V. Brainerdii* Greene, Pittonia 5: 89. 1902. Kidney-leaved Violet.

Rootstock ascending, commonly slender but becoming thick in old plants; acaulescent, 5–10 cm. tall, pubescent to subglabrous; stolons absent; leaf-blades rather thin, reniform-cordate, 3–6 cm. long and about as wide, the later leaves sometimes blunt-pointed, margins distinctly crenate-serrate; petioles longer than the blades, often twice as long; stipules linear; petals white, the lower frequently with purplish veins, obovate-spatulate, 6–10 mm. long, either beardless or the laterals with small tufts of hairs; spur short; sepals lanceolate, pale margined, half as long as the petals; peduncles from shorter than to slightly longer than the petioles; capsules ellipsoidal, purplish, 10–15 mm. long; seeds about 1.5 mm. long.

Newfoundland to Pennsylvania and west through Michigan and Minnesota to Saskatchewan and northward, also in the Black Hills of South Dakota and in the Rocky Mountains to Colorado. Colorado: wet ground in Engelmann spruce forests, 9,000 to 11,000 feet; rare. May–July.

3. Viola Selkirkii Pursh (ex Goldie) in Edinb. Phil. Journ. 6: 324. 1822. Great Spurred Violet.

Rootstock slender, creeping or horizontal; plant without stolons, acaulescent, 4–10 cm. high, nearly glabrous; leaf-blades thin, broadly cordate-ovate, short acute or obtuse, 1–4 cm. long, as broad or nearly as broad as long, crenate, upper surface hirtellous; petioles 1.5–7.0 cm. long; stipules ovate, often toothed at apex; petals pale violet, broadly spatulate or obovate, 5–10 mm. long, half as wide, beardless; spur nearly as long as petals, the end enlarged and round; sepals lanceolate or ovate-lanceolate, acute or somewhat acuminate, 4–6 mm. long, 2–3 mm. wide;

peduncle 3–7 cm. long; peduncles of cleistogamous flowers erect or ascending; capsule subglobose, 4–8 mm. long; seeds 1.5 mm. long, pale buff.

New Brunswick, Nova Scotia, and northward; south through New England to Massachusetts and Pennsylvania; west through Ontario and Minnesota to the mountains of British Columbia and south in the Rocky Mountains to New Mexico. Colorado: moist woods and shady ravines from 7,000 to 10,000 feet; rare. April–June.

4. **Viola palustris** L., Sp. Pl. 934. 1753. Marsh Violet.

Rootstock slender, scaly, creeping or horizontal; plant stoloniferous, acaulescent, 5–15 cm. tall, glabrous throughout; scapes generally surpassing the leaves, bracteolate at the middle or below; leaf-blades thin, ovate-cordate to orbicular or reniform, 2–4 cm. long, generally wider than long, the margin crenulate; petioles often twice as long as blades; stipules lanceolate, sometimes with a few subulate teeth at apex; petals pale lilac to nearly white with darker veins, obovate or broadly spatulate, 6–10 mm. long, the lateral petals bearded; spur short, thick and rounded; sepals ovate to ovate lanceolate, narrowly white-margined, 5–6 mm. long, obtuse; seeds dark brown, 1.5 mm. long.

Labrador south through the mountains of New England, west to Alaska, British Columbia, Washington, Oregon, and northern California, also in South Dakota and the Rocky Mountains to Colorado; Asia and Europe. Colorado: wet or moist soil in shady situations from 7,000 to 10,000 feet; infrequent. May–August.

4a. **Viola palustris** subsp. **brevipes** M. S. Baker, Madroño 3: 235. 1936.

This subspecies differs from the species in its smaller size and the pure white fragrant flowers with lateral petals entirely beardless. Estes Park and Moraine Park, Colorado.

5. **Viola pratincola** Greene, Pittonia 4: 64. 1899. *V. Sandbergii* Greene, Pittonia 5: 119. 1903. Meadow or Hooded Blue Violet.

Rootstock ascending; plant without stolons, acaulescent, 7–30 cm. high, usually glabrous; leaf-blades deeply cordate-ovate tapering gradually to subacute apex or sometimes abruptly pointed, 2–3 cm. wide at petaliferous flowering, 5–8 cm. wide at maturity, as long as wide, crenulate; petioles 2 or 3 times as long as the blade; stipules linear-lanceolate; petals violet, light at base, spatulate, 10–15 mm. long, 4–6 mm. wide, lateral petals somewhat bearded; spurred petal glabrous, rounded at apex; spurs short; sepals ovate-lanceolate, acute or obtuse; peduncles as long as or much longer than the leaves, bracteolate at or above the middle; cleistogamous flowers on short prostrate peduncles; capsules ellipsoidal, 6–10 mm. long; seeds 1.5–2.0 mm. long.

Minnesota and North Dakota to Wyoming and Colorado. Colorado: prairies and hills; open situations, 4,000 to 8,000 feet; infrequent. April–May.

6. **Viola nephrophylla** Greene, Pittonia 3: 144. 1896. *V. cognata* Greene, Pittonia 3: 145. 1896.

Rootstock generally ascending, moderately thick; plant without stolons, acaulescent 5–15 cm. tall, nearly or quite glabrous; leaf-blades firm, broadly cordate-ovate to reniform, obtuse, 1–3 cm. long, 1–4 cm. broad, crenate-serrate, late-season leaves larger; petioles slender, two or three times the length of the blades; stipules ovate-lanceolate; petals violet, lighter at base with purple veining, obovate, large, 10–15 mm. long, half as wide, pubescent to villous, the spurred petal villous, emarginate; spur rounded, about one-fourth the length of petals; sepals ovate to oblong, often rounded, 4–8 mm. long, 2–3 mm. wide; peduncles slender, 4–12 cm. long; cleistogamous flowers ovoid on slender short peduncles; capsules short-ellipsoidal, green, glabrous, 8–10 mm. long; seeds 2.0–2.5 mm. long, olive-brown.

South Dakota and west to British Columbia; south in mountain areas to New Mexico, Arizona, Utah, Nevada, and California. Colorado: low meadows, moist aspen groves, and sloping ground among bushes, 5,000 to 10,000 feet; moderately frequent. May–July.

This is the *V. nephrophylla* of Brainerd's account in Rydberg's "Flora of the Rocky Mountains and Adjacent Plains" (1917). I have seen no specimens which I could refer to *V. nephrophylla* as originally described by Greene from western Colorado. Plants of this species are conspicuous because of their firm leaf-blades, long slender petioles and peduncles, and large flowers.

7. **Viola retusa** Greene, Pittonia 4: 6. 1899. Western Blue Violet.

Rootstock ascending, stout; plant without stolons, acaulescent, 4–15 cm. high, glabrous throughout; leaf-blades at spring flowering broadly ovate or cordate-deltoid, acute or obtuse, 2–4 cm. long, 2–6 cm. wide, finely serrate; aestival leaves wider, reniform, often abruptly acuminate, the base cordate to truncate-decurrent, crenate-serrate; petioles 1–3 times as long as blades; stipules ovate, acuminate, sometimes toothed at apex; petals violet, the upper obovate, 10–15 mm. long, 5–6 mm. wide, lateral petals spatulate, somewhat bearded, spurred petal slightly hairy, retuse; spurs short and rounded; sepals lanceolate, white-margined, acute, 5–6 mm. long, 1–2 mm. wide; peduncle somewhat exceeding the leaves; cleistogamous flowers ovoid, on erect peduncles; capsules ellipsoidal, green, 10–12 mm. long; seeds brown, 2 mm. long.

Central Kansas, northwest and west to the mountain front and foothill districts of Colorado. Colorado: shady thickets and along streams from 4,000 to about 7,000 feet; moderately frequent. May–June.

8. **Viola Rafinesquii** Greene, Pittonia 4: 9. 1899. *V. bicolor* Pursh, Fl. Am. Sept. 1: 175. 1814, not *V. bicolor* Gilib. 1781. *V. tenella* Raf. in Medical Repository, N. Y. ser. 2, 5: 354. 1808 (*nomen*); Am. Monthly Mag. 191. 1819, not *V. tenella* Poir. 1810. Wild Pansy.

Annual, rootstock ascending, plant caulescent, 1–2 dm. high, lower part of stem somewhat pubescent with recurved hairs, becoming nearly glabrous with age; stems slender, often branching from base; lower leaf-blades suborbicular, 3–10 mm. long, upper oblong-lanceolate to ovate, 10–20 mm. long, 3–5 mm. wide, entire or crenate-dentate, attenuate at the base, margins minutely pubescent; petioles of lower leaves about twice as long as blades, of upper leaves one-third as long as blades; stipules foliaceous, 5–14 mm. long, palmately pinnatifid or laciniate, terminal segment elongate; petals cream-colored, blue or purplish spotted, obovate, 4–9 mm. long, 2–4 mm. wide; spur very short; sepals subulate, about half as long as petals, margins hirsutulous; peduncle 1.5–3.0 cm. long; capsule glabrous, 6 mm. long or less; seeds light brown, 1.5 mm. long.

New York to Michigan, south to Georgia, west through the Mississippi basin to Colorado and Texas. Colorado: moist sloping ground of plains and lower foothills, 4,000 to 7,000 feet; locally frequent. April–May.

9. **Viola Sheltonii** Torr., Pacif. Rail. Rep. 4: 67, t. 2. 1857. *V. biternata* Greene, Pl. Baker. 3: 12. 1901. Fan Violet.

Rootstock ascending, deep-seated; plant subacaulescent to caulescent, 5–15 cm. or taller, hirsutulous or nearly glabrous; leaf-blades 1–4 cm. long, and fully as wide, palmately 3-divided, the divisions palmately or pedately 3-parted and cleft; petioles 3–10 cm. long or longer; stipules lanceolate to ovate, scarious; petals yellow, strongly veined, tinged with brown beneath, obovate, 6–12 mm. long, half as wide as long, lateral petals slightly bearded; spur hardly one-third the length of the petals; sepals linear-lanceolate, acuminate, 4–8 mm. long; peduncles 5–15 cm. long; capsule globose, 6–8 mm. long, brown, glabrous; seeds buff, 2 mm. long.

Western Colorado to Washington, Oregon, and California. Colorado: rocky hillsides of the western slope of the Rocky Mountains from 7,000 to 9,000 feet; infrequent to rare. April–June.

10. **Viola biflora** L., Sp. Pl. 936. 1753. Alpine Yellow Violet.

Rootstock ascending; plant caulescent, 5–20 cm. high; stems slender, generally 2-leaved and 2-flowered; leaf-blades round-reniform, narrowly cordate at base, rounded at apex, 1–2 cm. long, twice as wide as long, somewhat hirtellous on upper surface and margins, crenulate; stipules ovate; petioles 3–8 cm. long; petals yellow streaked with dark purple-brown, spatulate, 6–8 mm. long; half as wide as long; spur short-conical; sepals linear-oblong, 4 mm. long; peduncles surpassing the leaves; capsule about 6 mm. long, ellipsoidal; seeds about 1 mm. long.

Northern Europe and Asia to Alaska; Colorado. Colorado: wet moss and dense herbaceous vegetation in fine alluvial soil along mountain streams from 8,000 to 11,000 feet; rare. April–July.

11. Viola linguaefolia Nutt., in Torr. & Gray Fl. N. Am. 1: 141. 1838. *V. flavovirens* Pollard, Bull. Torr. Bot. Club 24: 405. 1897. *V. erectifolia* Nels., Bot. Gaz. 29: 143. 1900. *V. gomphopetala* Greene, Pl. Baker. 3: 11. 1901.

Rootstock ascending, slender; plant caulescent or subcaulescent, erect, 1–3 dm. high, hirtellous to nearly glabrous; leaf-blades narrowly oblong to ovate-lanceolate, mostly obtuse, 5–9 cm. long, 1.5–3.0 cm. wide, entire or repand-denticulate, margins ciliate, veins generally hirtellous; petioles about twice the length of leaf-blades; stipules lanceolate, acuminate; petals yellow, veined with purple, often appearing reddish-brown in dried specimens, 10–15 mm. long, 5–8 mm. wide, upper petals obovate, lateral petals spatulate, usually somewhat bearded; spur very short; sepals linear-lanceolate, acuminate, 5–8 mm. long, margins usually ciliate; peduncle generally as long as or surpassing the leaves; late flowers cleistogamous from upper axils; capsule globose, usually glabrous; seeds 2–3 mm. long.

Montana to Colorado, west to Washington and northern California. Colorado: mountain valleys or coarse soil near lakes, 8,000 to 10,000 feet; infrequent. June–August.

12. Viola venosa (S. Wats.) Rydb., Mem. N. Y. Bot. Gard. 1: 262. 1900. *V. Nuttallii* var. *venosa* Wats., Bot. King Exped. 35. 1871. *V. atriplicifolia* Greene, Pittonia 3: 38. 1896. *V. Thorii* Nels., Bot. Gaz. 30: 193. 1900. Dwarf Yellow Violet.

Rootstock vertical or nearly so; plant caulescent, 5–15 cm. tall, glabrate to pubescent; stems many, ascending, short; lower leaf-blades ovate, obtuse, 1–2 (seldom 3) cm. long and two-thirds as wide, coarsely round-toothed or lobed and tapering into a long margined petiole, the upper leaves often three-lobed hastate; stipules lanceolate, entire; petals yellow tinged with purple dorsally (often quite purple in drying), obovate, 6–10 mm. long and half as wide, usually beardless; spur short; sepals hirtellous to pubescent, lanceolate, white margined, one-third to one-half the length of the petals; peduncles 2–5 cm. long, bracteolate halfway up; capsule nearly globose, 4–5 mm. long; seeds about 1 mm. long.

Montana and Wyoming, west through Idaho and Utah to Washington, Oregon and California. Colorado: northwestern part of the state on dry hillsides and in openings of dry coniferous forest, 6,000–8,000 feet. April–May.

13. **Viola Nuttallii** Pursh, Fl. Am. Sept. 1: 174. 1814. Nuttall Violet.

Rootstock ascending, semi-fleshy, occasionally branched or somewhat fascicled; plant caulescent, 5–25 cm. high, pubescent or glabrate to nearly glabrous; stems numerous, spreading rather than erect, generally short unless in a moist situation; leaf-blades oblong-lanceolate or linear-lanceolate, acute or subacute, 2–7 cm. long, 6–20 mm. wide, some puberulent, entire or repand-denticulate, tapering into margined petioles 3–12 cm. long; stipules lanceolate, entire; petals yellow and at times tinged with reddish-purple on outside, obovate, 8–12 mm. long, half as wide, slightly bearded; spur short; stigma bearded; sepals lanceolate or linear, acuminate, 5–10 mm. long; peduncle 3–8 cm. long; capsule subglobose, 7 mm. long, brown; seeds brown, 2.5–3.0 mm. long.

Manitoba and North Dakota to Missouri and Kansas, south in the Rocky Mountain states to New Mexico and Arizona. Colorado: prairies, plains, and foothills; open situations from 4,000 to 8,000 feet; common. April–June.

14. **Viola vallicola** Nels., Bull. Torr. Bot. Club 26: 128. 1899. *V. physalodes* Greene, Pl. Baker. 3: 12. 1901.

Rootstock short, with fascicled fleshy roots, ascending; plant caulescent, low, 4–12 cm. tall, glabrous or pubescent; stems somewhat spreading; leaf-blades ovate to lanceolate, obtuse, base rounded, basal leaves often subcordate, 2–5 cm. long, 1.0–2.5 cm. broad, generally puberulent with ciliate margins, entire or obscurely denticulate; petioles as long as the blades or longer; stipules lanceolate; petals bright yellow streaked with purple, obovate or broadly spatulate, 8–12 mm. long, half as wide, beardless or slightly bearded; spur short; sepals linear-lanceolate, acuminate, 5–7 mm. long; peduncle shorter than leaves or surpassing them; capsule broadly ovoid, 5–7 mm. long; seeds 1.5–2.0 mm. long.

North Dakota, Saskatchewan, British Columbia, and Washington, south in the Rocky Mountain area to Colorado. Colorado: moist valleys, 5,000 to 8,000 feet; infrequent. May–June.

15. **Viola bellidifolia** Greene, Pittonia 4: 292. 1901. *V. demissa* Greene, Pl. Baker. 3: 10. 1901. Subalpine Blue Violet.

Rootstock erect or ascending; plant glabrous, dwarf and tufted, 2–6 cm. tall, subacaulescent, the stems short and obscure; leaf-blades round-ovate, 5–16 mm. long, nearly as broad, obtuse at apex, obscurely cordate at base, entire or crenulate; petioles 1–4 cm. long; stipules linear-lanceolate, with a few bristly teeth;

petals violet-purple above, lighter below, obovate, 5–10 mm. long, 3–6 mm. wide; lateral petals slightly bearded; spur half as long as petals, often curved; sepals oblong-lanceolate, 3–5 mm. long, 0.5–1.0 mm. wide; peduncles numerous, 1.5–7.0 cm. long, generally surpassing the leaves, bracteolate above the middle; capsule subglobose, 5 mm. long; seeds 1.5 mm. long.

British Columbia, Montana and Idaho to Colorado; also in northern California. Colorado: mountain areas from 8,000 to 12,000 feet and higher, often in dense mixed herbaceous vegetation; rather frequent. June–August.

16. **Viola adunca** J. E. Smith, in Rees, Cycl. 37: pl. 63. 1817. *V. subvestita* Greene, Erythea 5: 39. 1897. *V. montanensis* Rydb., Mem. N. Y. Bot. Gard. 1: 263. 1900. *V. odontophora* Rydb., Mem. N. Y. Bot. Gard. 1: 164. 1900. *V. inamoena* Greene, Pl. Baker. 3: 11. 1901. *V. retroscabra* Greene, Pittonia 4: 290. 1901. Hooked Violet.

Rootstock ascending; tap root long; plant caulescent, 4–25 cm. high, glabrous to glabrate or puberulent or scaberulous; stems numerous; leaf-blades round-ovate or subcordate-ovate, some often ovate-trigonous, 1–4 cm. long, often as broad or nearly as broad as long, crenulate, truncate or cuneate at base, upper leaf-blades narrower; petioles 1–6 cm. long; stipules linear-subulate or linear-lanceolate, nearly entire, toothed or spinulose-serrate; petals violet-purple, obovate or broadly spatulate, 7–12 mm. long, 4–6 mm. wide, lateral petals bearded; spur 4–7 mm. long, straight, curved, or hooked; sepals linear-lanceolate, 5–7 mm. long, 0.5–1.0 mm. wide; peduncles 2–8 cm. long, often surpassing the leaves, bracteolate above the middle; capsule ellipsoidal, 6–7 mm. long; seeds 1.5–2.0 mm. long.

New Brunswick, eastern Quebec, and Vermont to Alaska, British Columbia, and California, south in the Rocky Mountain area to Colorado, Utah, and New Mexico. Colorado: hills and valleys; shaded situations, 5,000 to 10,000 feet; frequent. May–July.

16a. **Viola adunca** subsp. **Ashtonae** M. S. Baker, Madroño 3: 233. 1936. This subspecies differs from the species in the glabrous herbage, the somewhat smaller and paler corollas, the oblong-ovate to oblong-lanceolate (not linear-lanceolate) sepals, the short spur and the emarginate capsule. Cub Lake Trail, Estes Park, Colorado.

16b. **Viola adunca** subsp. **radicosa** M. S. Baker, Madroño 3: 234. 1936. This subspecies differs from the species in having dense short mostly retrorse pubescence throughout, the leaves often acuminate with the base tending to be truncate, and the capsule notched. Kawuneeche Valley, twelve miles north of Grand Lake, Colorado.

17. **Viola rugulosa** Greene, Pittonia 5: 26. 1902. *V. Rydbergii* Greene, Pittonia 5: 27. 1902. Rydberg Violet.

Rootstock ascending; plant caulescent, 1.5–4.0 dm. high, pubescent, stoloniferous; leaf-blades thickish, cordate-reniform, abruptly short-pointed, 1–7 cm. long, 2–10 cm. wide, serrate, hirsutulous especially beneath, upper leaves smaller and more often ovate-acuminate; petioles of root-leaves 3–20 cm. long, upper leaves with short petioles, 1–12 mm. long; stipules entire or nearly so, lanceolate, obliquely acuminate, not wholly scarious; petals violet or nearly white, purple veined, broadly spatulate or obovate, 6–12 mm. long, half as wide, lateral petals bearded; spur short; sepals subulate pointed, 3–7 mm. long, 1 mm. or less wide, minutely pubescent, margins white; peduncle 1.5–5.0 cm. long; cleistogamous flowers often appearing later; capsule ovoid to subglobose, minutely pubescent or nearly glabrous, 6–10 mm. long, greenish-brown; seeds brown, 1.5–2.0 mm. long.

Manitoba, Minnesota and Iowa, west to British Columbia, also in the Rocky Mountain area through Idaho, Montana, Wyoming, and Colorado to Arizona. Colorado: woods and shady streamsides from 5,000 to 9,000 feet; locally common. May, July or October.

This species is distinguished from the similar *V. canadensis* by the presence of stolons and the broader leaf-blades.

18. VIOLA CANADENSIS L., Sp. Pl. 936. 1753. *V. neomexicana* Greene, Pittonia 5: 28. 1902. Canada Violet.

Rootstock ascending; plant caulescent, 1.5–3.5 dm. high, nearly glabrous; leaf-blades thin, cordate-ovate, acuminate or acute, 1.5–6.0 cm. long, 1.5–5.0 cm. wide, serrate, teeth incurved, veins of under surface sometimes pubescent, smaller upper leaves often muriculate to hirtellous; petioles usually longer than blades, those of lower leaves often twice as long; stipules entire, lanceolate, obliquely acuminate, not wholly scarious; petals violet or nearly white, purple veined, broadly spatulate or obovate, 6–14 mm. long, 3–8 mm. wide, lateral petals bearded; spur short; sepals subulate pointed, 4–7 mm. long, 0.5–1.0 mm. wide, minutely pubescent, margins white; peduncles 1–8 cm. long; capsules ovoid or subglobose, mostly glabrous, 4–6 mm. long, brown; seeds brown, about 2 mm. long.

New Brunswick to South Carolina and Alabama, west and northwest through Ohio, Wisconsin, and South Dakota to northern Washington and Saskatchewan, south in the Rocky Mountain states through Colorado and Utah to New Mexico and Arizona. Colorado: moist woods and mountain slopes from 5,000 to 10,000 feet; frequent to common. April–June.

18a. VIOLA CANADENSIS L. var. SCOPULORUM Gray, Bot. Gaz. 11: 291. 1886. *V. scopulorum* (Gray) Greene, Pittonia 5: 27. 1902. A tufted and somewhat depressed form with small leaves and elongated peduncles, known only from Colorado.

University of Colorado,
Boulder, January, 1938.

THE GENERA OF THE TRIBE HYDROPHYLLEAE OF THE HYDROPHYLLACEAE

Lincoln Constance

A systematic study of *Nemophila,* which was undertaken with the objective of offering yet another revision of that genus, revealed not only difficulties in delimiting the species but also that lines traditionally accepted to separate the genera of the tribe Hydrophylleae did not, in certain cases, conform to natural boundaries. Hence, the study was broadened to include all those plants which have customarily been referred to the tribe, but concerned itself especially with *Ellisia* and *Nemophila.* The facts appear to necessitate a general realignment of these genera before monographic treatments of the several groups of species can be profitably presented.

Asa Gray (7) was the first writer to organize the three genera, *Hydrophyllum* L., *Ellisia* L. and *Nemophila* Nutt., into the tribe Hydrophylleae. He characterized the group principally by the possession of a unilocular ovary, largely filled at certain stages of development by two large fleshy parietal placentae, upon which the ovules are produced, and also by the presence of a single, more or less bifid style. This definition of the tribe has remained substantially unchanged to the present time, and is so accepted by Bentham and Hooker (4), Peter (15) and Brand (5). Some species have been removed by certain authors from each of the three genera under the segregates, *Eucrypta* Nutt., *Decemium* Raf. and *Pholistoma* Lilja, but conservative botanists have, in the main, retained not only the tribal grouping but also the three classical genera. The substitution of *Macrocalyx* Trew and *Nyctelea* Scop. for *Ellisia* and of *Viticella* Mitch. for *Nemophila* was based upon purely nomenclatorial considerations and can be disregarded in this discussion inasmuch as *Ellisia* has been conserved and *Nemophila* is on the list of *nomina generica conservanda proposita. Nemophila* has been in common use for more than a century and its retention also is to be advocated in the interest of nomenclatorial stability.

Hydrophyllum, distinguished by its perennial or biennial habit, usually basal but always alternate leaves, many-flowered, semi-scorpioid and usually congested inflorescence and exserted stamens, has been little confused with either of the other two genera, which are annual with chiefly cauline leaves and usually at least the lowest pair opposite, while the flowers are solitary or few in loose, raceme-like cymes and the stamens are included. Brand (5) has taken up *Decemium* (treated by Gray as a section of *Hydrophyllum*) and has constituted it a monotypic genus based upon *H. appendiculatum* Michx., which differs from members of section *Euhydrophyllum* Gray chiefly in possessing appendaged calyx-sinuses, an accrescent calyx, a biennial habit and only slightly exserted stamens. Because of the sporadic occurrence of these calycine conditions without close conformance to natural generic lines elsewhere in the tribe, and because the other two features appear to be scarcely of generic importance, it would seem advisable to retain this species within *Hydrophyllum*.

Various sets of characters have been drawn into service to distinguish *Ellisia* from *Nemophila,* but the difference most commonly emphasized—and the only one employed by Brand (5) in his generic key—is the presence in *Nemophila* of appendaged calyx-sinuses, as opposed to the absence of any such auricles in *Ellisia.* This lack of appendages on the calyx, indeed, is the only feature, save tribal similarities, possessed in common by all the species usually combined into *Ellisia.* Bentham (3), who first contrasted *Ellisia* with *Nemophila,* laying chief emphasis upon the presence or absence of auricles, clearly questioned the value of this distinction in the following words:

> " . . . in some instances the sinuses (as in some Campanulaceae) are furnished with reflexed appendages, resembling the erect divisions of the calyx in form, but smaller in size. . . . these divisions do not indicate any organic modifications in the composition of the calyx, but are merely owing to the prolongation of the united lateral nerves of two adjoining sepals. . . . The character derived from this circumstance must consequently be inconstant, and have little or no relation to general habit . . . and, if that be really the only distinction between *Nemophila* and *Ellisia,* it proves the expediency of uniting these two genera . . . *Nemophila* and *Ellisia,* when taken together, are a natural group, but are separated by a purely artificial character."

However, Bentham kept the genera separate in this and in a later (4) treatment. The two genera were actually merged by Baillon (2) who, without comment but doubtless influenced by Bentham's remarks, placed all the species of *Nemophila* under *Ellisia,* but did not make the necessary nomenclatorial recombinations. Chandler (6), in his excellent revision of *Nemophila,* noted that, "The question of the relation of *Nemophila* to *Ellisia* is vital, but must be left for future consideration."

The auricles of certain species of *Nemophila,* particularly *N. pulchella,* are frequently obsolete, so that Brand (5) cited under both genera specimens referable to this one species. Many specimens of *Ellisia Nyctelea,* type species of its genus, show occasional sepaloid teeth which are scarcely distinguishable from auricles.

Additional distinctions which have been used to separate the two genera are these: (1) the non-enlargement of the fruiting-calyx in *Nemophila,* its marked accrescence in *Ellisia;* (2) the presence of a deciduous cap of colorless cells (the "caruncle," "calyptra" or "cucullus") at the chalazal end of the mature seed in *Nemophila,* its complete absence in *Ellisia;* (3) the presence of corolla-scales in *Nemophila,* a pair at the base of each filament, as opposed to their obsolescence or absence in *Ellisia;* and (4) the fact that the corolla usually exceeds the calyx in *Nemophila* but is shorter than the calyx in *Ellisia*. A detailed consideration of this formidable array of differences, however, leads to the discovery of important contradictions in all of them.

The calyx of *Nemophila breviflora, N. Kirtleyi* and *N. phacelioides*, especially, is more strongly accrescent than that of *Ellisia chrysanthemifolia* or *E. micrantha*, whereas the calyx of all species of both genera enlarges to some degree in fruit. *Nemophila aurita* and *N. racemosa* entirely lack the distinguishing cucullus on the seed, and that on the seed of *N. breviflora, N. microcalyx* and *N. phacelioides* is reduced and persistent. The interstaminal scales in species of *Ellisia* are often more conspicuous than the squamae in certain collections of *Nemophila*, many of whose species have forms with the scales reduced to pubescent lines or quite obsolete. The corolla of *N. breviflora* is definitely shorter than the calyx, that of *N. parviflora, N. pedunculata* and varieties of *N. pulchella* often scarcely exceeds it, and that of *Ellisia membranacea* and *E. chrysanthemifolia* is distinctly longer than the calyx. None of these characters, then, is without striking exceptions which would seem to diminish the height of the traditional generic barriers.

Whereas *Nemophila* has not been sectionally divided by anyone, its members usually being keyed out on artificial characters, *Ellisia* has been recognized as a compound group consisting of section *Euellisia* Gray and section *Eucrypta* (Nutt.) Gray. The chief criteria employed by Nuttall (14) in founding *Eucrypta* as a genus were, first, its unique habit of bearing ovules upon both outer and inner faces of the placentae, and, secondly, the production of two very distinct types of seed in the inner and outer chambers thus formed. The subsequently discovered *E. micrantha* breaks down the second character because its seeds are homomorphic, but Brandegee's detection of the occasional presence of ovules on the side of the placentae away from the true locule has led to the association of this species with those which were known to Nuttall and included by him in *Eucrypta*. The fact that Bentham described *Ellisia* (*Eucrypta*) *chrysanthemifolia* as a congener of *E.* (*Euellisia*) *Nyctelea* without noting the presence of the "hidden" ovules and continued to maintain this position for the species even after this peculiarity had been pointed out, undoubtedly exerted a marked effect upon treatments by contemporary and later botanists.

The fruit and seed characters of *Eucrypta* are, in the writer's opinion, of more diagnostic weight than the presence or absence of appendaged calyx-sinuses in determining natural generic lines, as is admirably shown by the fluctuation of the auricle character within *Nemophila* and *Hydrophyllum*. Green (8) has adequately summed up the reasons for restoring *Eucrypta* to generic rank, in the following statement:

> "These plants are not at agreement with *Ellisia* in habit. But if they were, capsules of such remarkable structure, and with seeds of two sorts so

> strikingly dissimilar, neither sort answering to those of *Ellisia* or of any other Hydrophyllaceous genus, must, it seems to the writer, establish strongly enough a genus which was long ago well defined by an eminent authority. The name (meaning 'well hidden') is very admirably appropriate; for the pair of flattened seeds (rarely by the abortion of one ovule, solitary) which lie between the wall of the valve and its placenta, are so closely sealed as to have escaped the detection of that great botanist, the late Mr. Bentham, into whose hands one or both of the species fell at an earlier date than that of Mr. Nuttall's treatment of them, and who therefore described the plant as if it had been a real *Ellisia.*"

In addition, the species which possess this peculiar condition of ovule formation also agree closely in their usually delicate habit, in the viscid and aromatic condition of their dissected, fern-like foliage, in the hispid pubescence, in their relatively complicated cymose inflorescence and in their narrow and rather shallowly divided calyx and corolla. Their distribution, chiefly in the arid portion of the southwestern United States, is comparable and suggests a common Mexican origin for the group. In the light of the foregoing arguments, the writer proposes to follow Nuttall (14), Greene (8), Heller (10, 11), Abrams (1) and Rydberg (16) in recognizing *Eucrypta* as a valid genus.

Because fruit and seed characters have been given so much weight in the genus *Phacelia,* and especially in the neighboring family Boraginaceae, the writer anticipated that something of value might be revealed by a comparison of the seeds of those species comprising *Ellisia* section *Euellisia* with those of *Nemophila.* The seeds of *Ellisia Nyctelea, E. membranacea, Nemophila aurita* and *N. racemosa* were found to be nearly globose and regularly reticulate or alveolate, and entirely devoid of any cucullus. Those of the remaining species of *Nemophila,* on the other hand, were mostly ovoid, smooth or tuberculate and variously pitted, but never either reticulate or alveolate, and always with a cucullus. The capsules of *Ellisia membranacea, Nemophila aurita* and *N. racemosa* are armed with stout prickles and bristles, a condition not duplicated elsewhere in the tribe Hydrophylleae. Furthermore, these three species agree in the possession of a peculiar scandent habit, the prickly armature of the stems and a closely comparable geographic range, which again points to a southern origin. These facts appear to confirm the suggestion that this group is a natural one. The close resemblance of the three species was intimated by Greene (9), who transferred *Ellisia membranacea* to *Nemophila* with the remark that this species is, "Thoroughly congeneric with *N. racemosa;* only empirically placed under '*Ellisia,*' notwithstanding the absence of calyx-bractlets." Similarly, Jepson (12), while restoring this species to *Ellisia,* referred to the same plant as, "In vegetative habit strikingly similar to *Nemophila aurita.*"

The generic name *Pholistoma* was proposed by Lilja (13) with *Nemophila aurita* Lindl. as its type species. Although he based the genus chiefly upon minor characters, the name was effectively published and a recognizable type species designated, so that it is available for further use. The writer proposes to take up *Pholistoma* for *Ellisia membranacea, Nemophila aurita* and *N. racemosa* (appropriate recombinations are to be included in a further paper on *Pholistoma*) because if they were thrown, collectively, into either *Nemophila* or *Ellisia,* because of their resemblance to certain species of each genus, the generic characters would be so weakened that *Nemophila* and *Ellisia* would have to be regarded as a single, unwieldy group, to be known henceforth by the Linnean name of *Ellisia.* Their segregation, it is believed, will achieve a more natural arrangement within the tribe, and free both *Ellisia* and *Nemophila* of discordant elements.

With the removal of section *Eucrypta* and the transference of one species to *Pholistoma, Ellisia* is restricted to the original species, *E. Nyctelea,* and so becomes a monotypic genus as it was known to Linnaeus. Its globose reticulate seeds are closely similar to those of *Pholistoma,* but it lacks the scandent habit, possesses a pubescent rather than a prickly stem, an unarmed capsule, and a very small, tubular-campanulate corolla. The predominantly temperate eastern American distribution of *Ellisia Nyctelea,* although outlying stations occur in the plains area of western Montana and of northeastern New Mexico, contrasts strikingly with the southwestern occurrence of *Pholistoma,* and indicates that the separation has been one of long duration. The fact that the corollas are narrowly campanulate and usually shorter than the calyx suggests an affinity, pointed out by Rydberg (16), with *Nemophila breviflora,* which, however, has quite different pitted and cucullate seeds, and with *Eucrypta,* which differs in its viscid herbage, more numerous flowers, weakly enlarging calyx, falsely pentalocular capsule, smooth or corrugated seeds and its widely different ecological and geographical range. The maintainence of *Ellisia* as a monotypic genus, then appears to be a satisfactory alternative to the dubious policy of including the very unlike species of *Nemophila, Pholistoma, Ellisia* and possibly even *Eucrypta* within the same genus. If all of these were merged, it would be exceedingly difficult to justify the exclusion of *Hydrophyllum* from the amorphous group which thus would be created.

Pollen morphology and chromosome number, it was hoped, might afford additional evidence as to phylogenetic relationships within the tribe. Preliminary and unpublished results seem to indicate, however, that a general similarity in microspore structure and in chromosomal complement prevails throughout the group.

The foregoing discussion can now be summarized in the form of a key to the genera as they are accepted by the writer, and which will be treated individually in revisionary papers which are either completed or in the course of preparation.

Key to the Genera

Perennial or biennial; leaves chiefly basal and all alternate; flowers numerous in scorpioid and often congested cymes; stamens exserted .... 1. *Hydrophyllum* L.

Annual; leaves chiefly cauline, at least the lowest pair usually opposite; flowers solitary or several in loose simple or panicled cymes; stamens included.

  Herbage variously pubescent, bristly, prickly or glabrate, but neither viscid nor scented; ovules borne only on the axial face of the placentae.

    Seeds lacking a cucullus, nearly globose and regularly reticulate or alveolate.

      Succulent, scandent herbs with prickly stems; corolla exceeding calyx; capsules armed with stout prickles or bristles .... 2. *Pholistoma* Lilj.

      Flaccid herbs with hispid or glabrate stems; corolla exceeded by calyx or barely equalling it; capsules pubescent but unarmed .... 3. *Ellisia* L.

    Seeds cucullate, mostly ovoid and smooth or tuberculate, often pitted and scrobiculate, but neither reticulate nor alveolate .... 4. *Nemophila* Nutt.

  Herbage viscid and scented; ovules borne on both axial and abaxial faces of the placentae .... 5. *Eucrypta* Nutt.

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University of California, Berkeley,
August 28, 1938.

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A NOTE ON THE OCCURRENCE OF SALVIA IN THE NEW WORLD

Carl Epling

The subgenus *Calosphace* of *Salvia* includes nearly five hundred species, and, due to the localized nature of many of the species, each venture from the beaten path within the tropics brings new species to light. This large group is homogeneous but nevertheless separable into a series of species constellations ninety-two in number. These vary in size from monotypic groups to groups of forty species or more. Each gives the impression of an immediate origin from a single source through means other than hybridization, as though through fragmentation of a single species. In general the species which comprise them are of the same growth form with essentially similar habits of inflorescence. They have flowers of essentially the same conformation, which differ nevertheless in size and proportion. Such constellations differ among themselves by differences in habit, in inflorescence and in the details of flower structure. Each suggests a species group of close relationship and not improbably form coenospecies in the sense of Turesson. I have treated them as sections.

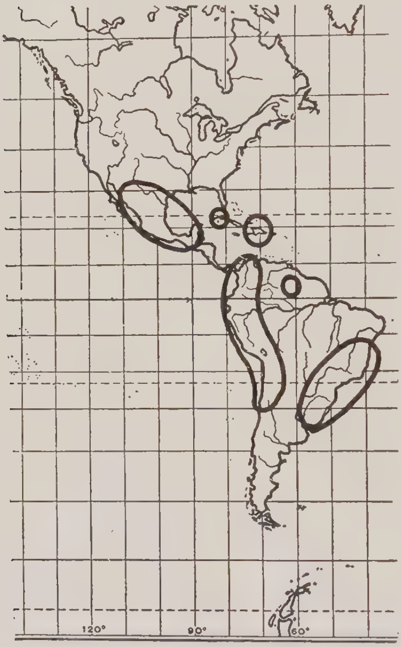

Fig. 1. Chart showing the principal concentration areas of *Labiatae* in the New World.

The distribution of *Salvia* subgenus *Calosphace* in the New World is characteristic of most of the genera of Labiatae which are confined to the New World. The distribution of those genera which are also Eurasian is of a different nature and will be dealt with in a later paper. While it is true that the genus ranges continuously from the Great Lakes to the plains of Argentina it is concentrated in three principal areas of wide extent and three small subsidary areas which are characterized by endemism. The first mentioned are the highlands of Mexico, particularly the central portion, the northern Andes and the Brazilian highlands. The subsidiary areas which are characterized in some degree by endemism are the

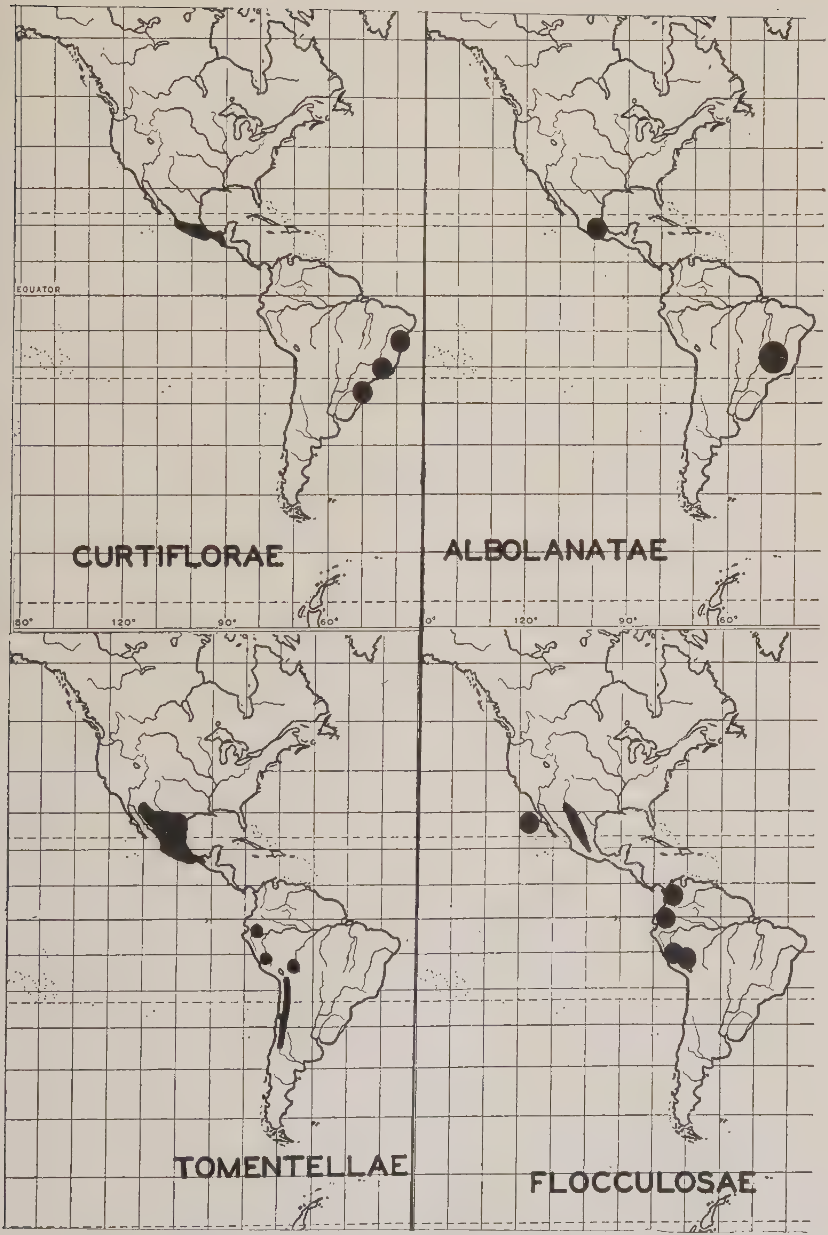

FIG. 2. Charts showing the distribution of *Salvia,* subgenus *Calosphace,* sections *Curtiflorae, Albolanatae, Tomentellae* and *Flocculosae.*

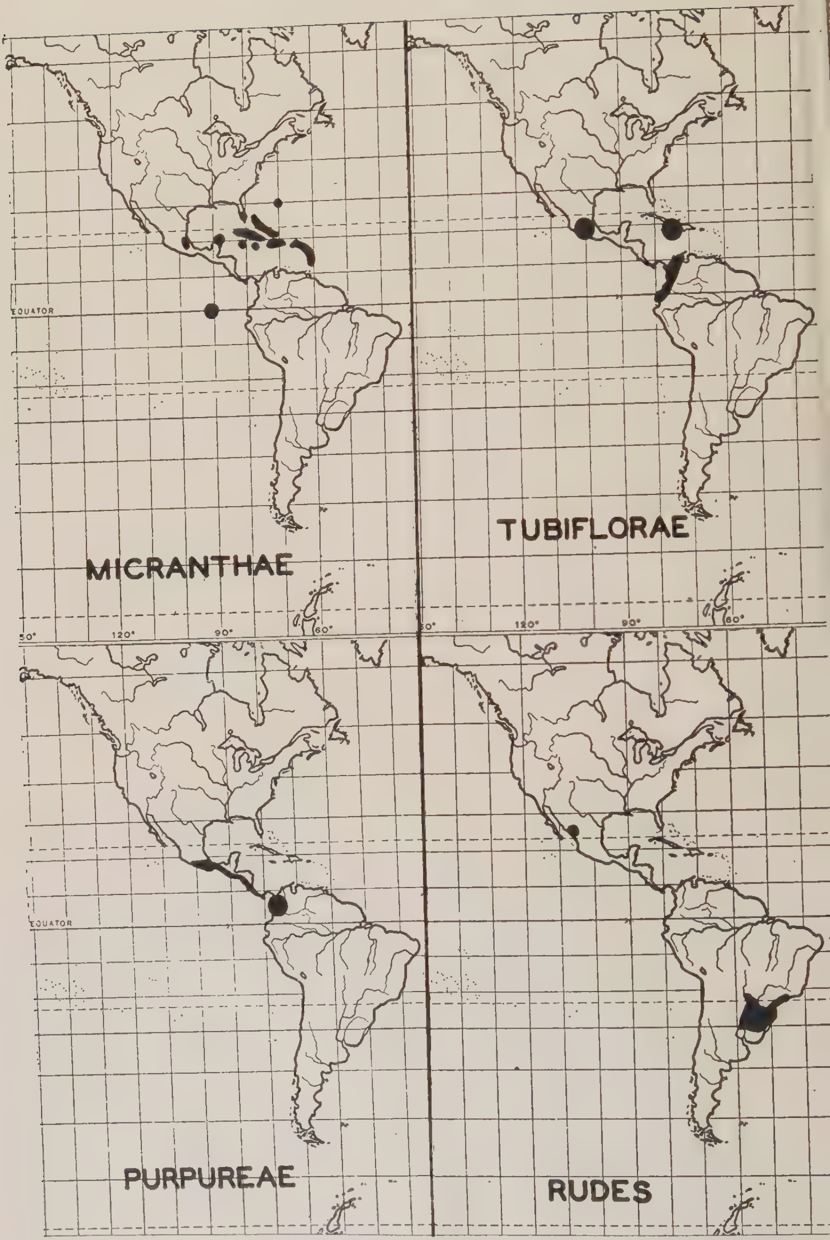

Fig. 3. Charts showing the distribution of *Salvia,* subgenus *Calosphac* sections *Micranthae, Tubiflorae, Purpureae* and *Rudes.*

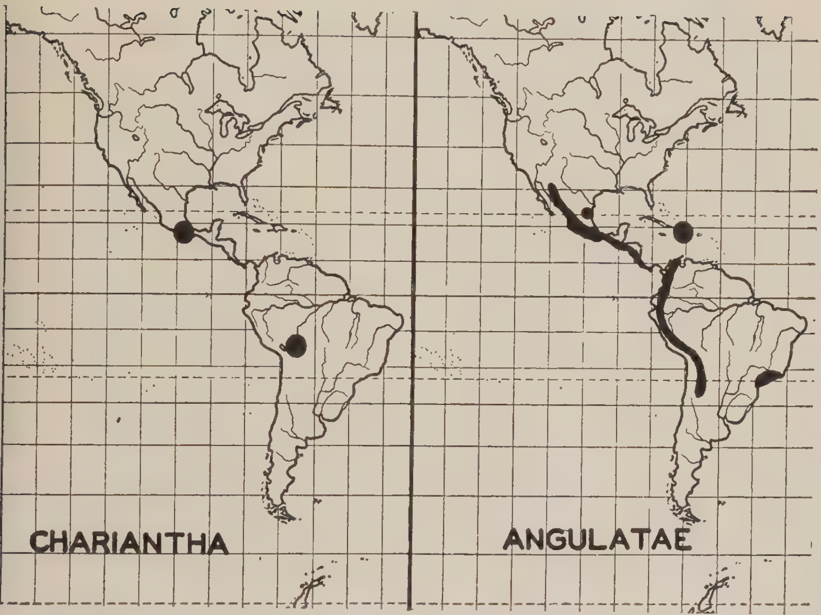

Fig. 4. Chart showing distribution of *Salvia,* subgenus *Calosphace,* sections *Chariantha* and *Angulatae.*

highlands of British Guiana, the mountains of Haiti and the mountains of Cuba (including the Isle of Pines). The areas of distribution of the sections are usually restricted and are generally one of three types. The first is illustrated by the sections *Chariantha, Flocculosae* and *Tomentellae.* In this case species of the Mexican highlands find close counterparts in species of the Andes, particularly of Ecuador and Peru. The second is illustrated by the sections *Albolanatae, Curtiflorae* and *Rudes.* In this case species of the Mexican highlands find close counterparts in the highlands of Brasil, *but not in the Andes.* The third case is largely a Caribbean distribution in which the section occurs more or less continuously in the islands of the Caribbean and the isthmus or the northern part of South America, usually at lower elevations. This is illustrated by such sections as *Micranthae, Tubiflorae* and *Purpureae.* Only the large section *Angulatae* is general throughout most of these areas.

Not only *Salvia* subgenus *Calosphace* but most of the genera of Labiatae which are confined to the New World (in contrast, for example, to those which are circumpolar) conform to this pattern; the significance of this fact is unknown.

University of California at
Los Angeles, April 20, 1938.

NOTES ON THE GENUS ARCTOSTAPHYLOS[1]

A. E. Wieslander and Beryl O. Schreiber

In the mapping of the vegetation types of California and western Nevada, the species of *Arctostaphylos,* because of their widespread abundance throughout most of the region and because of their great variation, have presented a difficult problem. It has been necessary, in supervising this mapping project during the past twelve years, to devote much time to the study of this genus in the field. In this study we have had the cooperation of the late Dr. Harry S. Yates, botanist of the project, and the active assistance of every field worker on the survey. The senior author has also had invaluable advice and assistance from Dr. W. L. Jepson, of the University of California, not only pertaining to *Arctostaphylos* but to many other botanical problems concerning the vegetation survey.

In differentiating the species of *Arctostaphylos* the presence or absence of a burl at the base of the stem and the character of the nascent inflorescences have proved most valuable. These characters have not been extensively noted or used by previous workers in this genus.

The presence of a burl is related to the capacity of a species to sprout following fire or cutting. Dr. W. L. Jepson in 1916 pointed out the sprouting character of certain species in contrast to the nonsprouting character of others and suggested the value of this criterion for differentiating species (Madroño 1: 3–11. 1916). In 1922 he further developed the use of this character as a basis for species differentiation (Madroño 1: 76–77. 1922). The senior author, as a student of Dr. Jepson, had become acquainted with this behavior of *Arctostaphylos* in the Mount Tamalpais region. When he was assigned to map the vegetation of the state in 1926 and was requested at the same time to determine the sprouting capacity of each species of the chaparral because of its practical bearing on the construction and maintenance of firebreaks, "sprouting" or "nonsprouting" became the first point of observation in the field identification of all trees and shrubs encountered. A record of this character was entered on the field

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[1] Contribution No. 1 from the Vegetation Type Map Herbarium of the Forest Survey Division of the California Forest and Range Experiment Station. The senior author is in charge of the Forest Survey; the junior author is supervising botanist, Project No. 365–03–3–35, conducted under the auspices of the Works Progress Administration.

[While this article was in press, Dr. W. L. Jepson, to whom a copy of the manuscript was submitted for criticism on November 17, 1938, published two papers, "Embryonic Panicles in Arctostaphylos" (Erythea 8: 97. December 22, 1938) and "Three New Californian Arctostaphyli" (l.c. 8: 99). The use of my name as co-author of *A. pilosula* Jepson & Wieslander, *A. rudis* Jepson & Wieslander, and *A. silvicola* Jepson & Wieslander was unauthorized and without my knowledge or consent. A. E. Wieslander.]

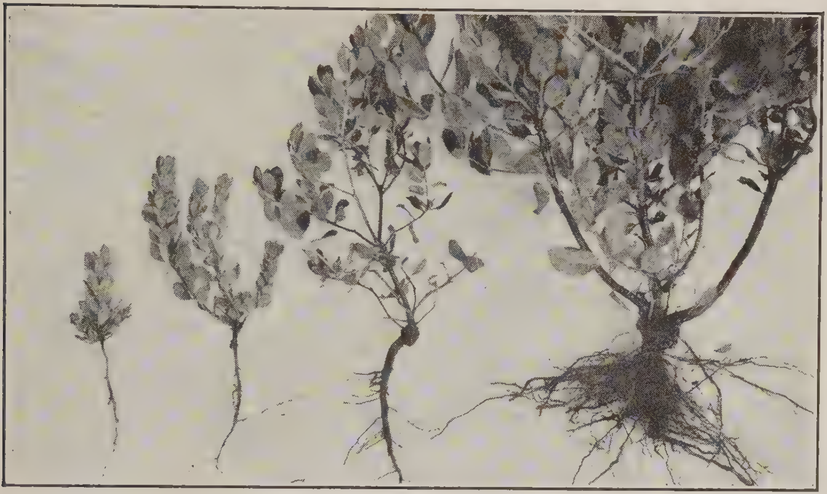


FIG. 1. *Arctostaphylos glandulosa.* Development of the burl in a typical sprouting species.

label of each herbarium specimen collected. The sprouting character is, in most instances, readily observable but may be obscured because of lack of evidence of fire. For this reason field workers were often confused. Either sprout regeneration was lacking because no fire or cutting had taken place since the seedling stage or else the layering habit of many of the species was mistaken for sprouting. In an effort to clear up this difficulty we were rewarded by the observation that the burl is not a reaction of the species to mutilation by fire or cutting, as many have understood it to be, but a normal structure which appears early in the life of the seedling as a few nodules, develops steadily with increasing age, and ultimately attains a diameter of a foot or more, even where fires have never occurred. The exterior surface of a large, well developed burl is simply an aggregation of latent buds, which sprout as a result of injury by fire or other agencies. Fire may affect the size and shape of the burl, but is not responsible for its existence. The nature and development of the burl in a typical sprouting species is shown in text figure 1. Since, therefore, the presence of the burl can be observed even in very young plants, its value as a taxonomic criterion is greatly enhanced.

Nascent inflorescences as shown in text figure 2 develop in most species of *Arctostaphylos* during the early summer and remain in this dormant condition until just prior to blooming. In the warm coastal belt of California these structures emerge from the dormant condition soon after the fall rains which initiate growth, but at higher and cooler elevations they remain dormant until spring. The value of this character in segregating species was first called to our attention in 1931 by Mr. H. A. Jensen, who is associated with us on the type mapping project. On the Hoaglin Quadrangle in Trinity County Mr. Jensen found this character useful in differentiating *A. manzanita* Parry, *A. canescens* Eastw., and *A. viscida* Parry, none of which forms a burl. Although previous use has not been recorded in the literature, Dr. Jepson has informed the senior author that he also had noted the value of the nascent inflorescence character of many of the manzanitas in the Napa region. The usefulness of this character is enhanced by the fact that it is observable over a very long period each year. During subsequent mapping work it has proved an excellent field character for differentiating many of the species. In the following descriptions, special reference is made to the presence or absence of burls and to the nature of the nascent inflorescences.

The type collections are filed in the Vegetation Type Map Herbarium, California Forest and Range Experiment Station, located in the University of California Herbarium at Berkeley. Isotypes have been distributed to the United States Forest Service Herbarium, the United States National Herbarium at Washington, D. C., and the University of California Herbarium. In citing specimens the following symbols represent the various herbaria consulted: VTM, Vegetation Type Map Herbarium; UC, University of California Herbarium; D, Dudley Herbarium, Stanford University; CAS, California Academy of Sciences, San Francisco.

ARCTOSTAPHYLOS SILVICOLA sp. emend. *A. silvicola* Jepson and Wieslander, Erythea 8: 101. 1938.

Silvery gray shrub, 20–25 dm. high; no burl formation at base; bark smooth, deep dark red; branchlets densely gray-canescent with soft hairs; leaves elliptic to oblong-elliptic, obtuse or apiculate at the apex, rounded-cuneate at the base, densely gray-canescent, or occasionally glabrate, 15–40 mm. long, on petioles 3–8 mm. long; nascent inflorescence (text fig. 1, b) short, 9–13 mm. long, sessile or on peduncles 2–4 mm. long, campanulate, pendulous or slightly spreading, 1–3 in a cluster, bracts leafy, lanceolate, 4–12 mm. long, the tips slightly recurved, densely canescent, gray green, tinged pink; flowers white, 5–6 mm. long, on glabrous or hairy pedicels; ovary glabrous or rarely hairy; berry globose, slightly depressed at the apex, 5–10 mm., orange brown, glabrous, rarely slightly hairy; nutlets separate.

Distribution. Ridges above Mount Hermon and Bonnie Doon, Santa Cruz County, on marine sand deposits, associated with *Pinus ponderosa, Arctostaphylos tomentosa, Adenostoma fasciculatum, Ceanothus Ferrisae, Ericameria ericoides,* and *Lupinus albifrons.*

Specimens to verify range. SANTA CRUZ COUNTY: Mount Hermon, *A. E. Wieslander 277* (VTM 2467); near Bonnie Doon, *H. S.*

Yates 5020 (VTM 8019); Big Trees, *C. W. Hanks 169* (VTM 8730); Mount Hermon, *H. E. McMinn 1699* (D); Ben Lomond, *A. D. E. Elmer 4606* (D, CAS); near Tuxido, April 17, 1904, *W. R. Dudley* (D, CAS); Scott's Valley, *L. R. Abrams 10903* (D); near Eccles, June 27, 1897, *W. R. Dudley* (D, CAS); above Bonnie Doon, March 29, 1899, *W. R. Dudley* (D); Glenwood, Feb. 7, 1914, *Horace Davis* (CAS); Mount Hermon Ridge, *Beryl Schreiber 2567* (VTM 23756); Felton (Mount Hermon Ridge) *C. M. Belshaw 1482* (VTM 13639); Mount Hermon, *A. E. Wieslander 701* (VTM 17279).

Arctostaphylos silvicola may be distinguished from *A. canescens* Eastw. by its smaller, elliptic leaves. The nascent inflorescence of *A. silvicola* is usually pendulous, although occasionally slightly spreading, and the tips of the bracts tend to recurve, whereas in *A. canescens* they are generally erect or spreading on arcuate peduncles. The ovary and fruits of *A. silvicola* are glabrous, rarely hairy, while in *A. canescens* the ovary is densely long white-hairy and the fruits are usually pubescent or sometimes slightly glandular, or glabrate with a glaucous bloom.

Arctostaphylos silvicola forms large silvery gray masses in the chaparral and is the dominant member of the vegetation growing under *Pinus ponderosa.* It also occurs in nearby pure stands as a fire type replacement of *Pinus ponderosa* in these localities.

ARCTOSTAPHYLOS RUDIS sp. emend. *A. rudis* Jepson and Wieslander, Erythea 8: 100. 1938.

Low shrub, to 15 dm. high, forming burls at the base and frequently on the lower branches; bark reddish brown, rough and shreddy; branchlets finely gray-pubescent; leaves elliptic to oblong, occasionally oval, usually rounded at the base, or occasionally truncate, apiculate or obtuse at the apex, glabrous or lightly pubescent especially on the young leaves, bright green, 15–30 mm. long, on pubescent petioles 3–6 mm. long; nascent inflorescence (text fig. 2, e) short, oblong, 5–6 mm. long, 1–3 at the tips of the branchlets, pendulous, bracts mostly scalelike, ovate to awl-shaped, acute or acuminate, when acuminate the tips recurved, 2–3 mm. long, reddish or pale green, finely pubescent; flowers 5–6 mm. long, on glabrous pedicels, pinkish; ovary glabrous; fruit globose, 9–11 mm. wide, glabrous, light brown or reddish brown when mature; nutlets separate.

Distribution. Dune sands near Oceano, San Luis Obispo County, south in the vicinity of Lompoc, Santa Barbara County, 150–600 feet elevation, associated with such plants as *Arctostaphylos pechoensis* var. *viridissima, Ceanothus dentatus* var. *impressus, Rhamnus californica, Adenostoma fasciculatum, Salvia mellifera,* and *Ericameria ericoides.*

Specimens to verify range. SAN LUIS OBISPO COUNTY: Oceano, *N. French 663* (VTM 13592); near Los Berros, *A. E. Wieslander*

136 (VTM 2528). Santa Barbara County: Corralillos Canyon, *A. E. Wieslander 577* (VTM 12520); Surf, *G. E. Sindel 179* (VTM 8390); Burton Mesa, *H. S. Yates 6534* (VTM 19229); Lompoc Mesa, *A. E. Wieslander 235* (VTM 2286); Burton Mesa, *H. L. Mason 11770* (UC); Lompoc, March 3, 1937, *E. Denys Rowe* (UC); Lompoc Moor, *Ralph Hoffmann 376* (CAS); 4 miles southeast of Lompoc, *Roxana S. Ferris 7605* (D); Lompoc Mesa, *Beryl Schreiber 2562* (VTM 23749); Lompoc Mesa, *A. E. Wieslander 644* (VTM 15473); Point Sal, *A. E. Wieslander 813* (VTM 23744).

Arctostaphylos rudis is distinct from all other coastal manzanitas which form burls. The shaggy fibrous bark separates it from the *A. glandulosa* Eastw. group and the small, elliptic, glabrous or glabrate leaves distinguish it from the *A. tomentosa* Lindl. group. The nascent inflorescences including the peduncles are shorter and more slender than in either the *A. tomentosa* or the *A. glandulosa* complex, and the fruit is glabrous, polished, considerably larger, and more profuse.

Arctostaphylos morroensis sp. nov.

Frutex 15–20 dm. altus; caudex etumescens; cortex asper laciniosus porphyreus vel cinereo-fuscus; ramuli pubescentes pilis adpressis, densis brevibus, interdum pilis longis rigidis admixtis; folia 15–30 mm. longa oblonga vel raro elliptica, plerumque truncata, aliquando basi subcordata vel raro rotunda, apice plerumque apiculato, aliquando obtuso, flavovirentia vel cinereo-viridia, subtus dense tomentosa supra sparse pilosa vel glabra; petioli 2–4 mm. longi; inflorescentia nascens 7–9 mm. longa solitaria numerosave in axillibus foliorum superiorum aggregata; bracteae foliaceae, lanceolatae minute pubescentes, aliquando pilis rigidis admixtis; pedicelli glabri; corolla alba vel puniceo-tincta 5–7 mm. longa; ovarium dense pubescens; drupa matura diametro 10 mm. globosa vel paullo depressa, aurantiaco-ferruginea, sparse pubescens; pyrenae liberae.

Shrub 15–20 dm. high; no burl formation at the base; bark rough and shreddy, red brown or gray brown; branchlets appressed-pubescent, and with dense, short, or long bristly hairs, or the latter lacking; leaves oblong to rarely elliptic, 15–30 mm. long, usually truncate but frequently subcordate or rarely rounded at the base, apex usually apiculate but occasionally obtuse, on petioles 2–4 mm. long, yellowish green or gray green, densely tomentose on the under surface, sparingly pubescent to glabrous above; nascent inflorescence (text fig. 2, a) short, campanulate, 10–14 mm. long, 1 to several, clustered in the upper leaves, mostly pendulous, bracts leafy, lanceolate, 7–9 mm. long, and finely pubescent, coarsely bristly or bristles lacking; flowers white to pink tinged, 5–7 mm. long, on glabrous pedicels; ovary densely pubescent; fruit globose, or slightly flattened, orange brown when ripe, 10 mm. in diameter, lightly pubescent; nutlets separate.

Types. Nascent inflorescence: south of Morro Bay (Hazard Canyon), San Luis Obispo County, 200 feet elevation, October 7, 1938, *Beryl Schreiber 2554* (VTM 23740). Flowering specimen: 0.4 mile north of Hazard Canyon (south of Morro Bay), 200 feet elevation, January 31, 1936, *Ben Bolt 561* (VTM 13800). Fruiting specimen: south of Morro Bay (Hazard Canyon), 250 feet elevation, May 12, 1936, *A. E. Wieslander 639* (VTM 15468).

Distribution. Sandy hills south of Morro Bay, 100–400 feet elevation, associated with *Adenostoma fasciculatum, Salvia mellifera, Lotus scoparius,* and *Ericameria ericoides.*

Specimens to verify range. SAN LUIS OBISPO COUNTY: Morro Bay, *A. E. Wieslander 640* (VTM 15469); Hazard Canyon, *A. E. Wieslander 647* (VTM 17235); Los Osos Ranch, *N. French 709* (VTM 14085); Osos Creek, *B. Bolt 541* (VTM 13783); Valencia Peak, *B. Bolt 644* (VTM 14631); Morro sands, *Alice Eastwood 14945* (CAS); Haynes Ranch, Morro Bay, July, 1912, *Mary Page Ingalls* (CAS); road to Pecho, *Alice Eastwood 15107* (CAS, D); Morro Bay on road to Pecho, February, 1929, *Gertrude Sinsheimer* (UC, D).

Arctostaphylos morroensis may be distinguished from *Arctostaphylos tomentosa* by the absence of a burl at the base of the shrubs. In all of the *A. tomentosa* series burls were formed even on the young seedlings, these developing into great massive growths on the mature plants. The nascent inflorescences of *A. morroensis* are campanulate, while those of *A. tomentosa* are oblong and more rigid or spikelike. Characteristically the leafy bracts in *A. morroensis* are coarsely bristly ciliate but these bristles are occasionally lacking. The bracts of *A. tomentosa* are usually merely pubescent. The pedicels in *A. morroensis* are glabrous, whereas in *A. tomentosa* they are pubescent.

Arctostaphylos morroensis is the common shrub in the chaparral at the south end of Morro Bay, frequently forming compact masses over extensive areas. It has been reported as far south as Valencia Peak, 2.5 miles south of the type locality (*B. Bolt 644* (VTM)). The specific name is derived from the locality where the species is found.

Arctostaphylos otayensis sp. nov.

Frutex erectus, 10–25 dm. altus; caudex etumescens; cortex laevigatus, atroruber; ramuli breves glandulosi-pilosi; folia 13–35 mm. longa elliptica vel oblonga, apice acuto apiculatove basi rotunda vel raro truncata utrinque minute pubescentia sub microscopio glandulosa raro glabrata cinereo-viridia vel flavovirentia; inflorescentia nascens breve oblonga 10–20 mm. longa, 3–8, in apicibus ramulorum terminalis, foliis supremis proxissimis subtendita, erecta vel alabastris crescentibus paullo arcuato-adcendens; bracteae 3–15 mm. longae foliaceae, glanduloso-pilosae;

pedicelli glanduloso-pilosi; drupa 5–8 mm. diametro globosa pallidissimo-ferruginea, nitida glabra, sparse pilosa vel sub microscopio glandulosa; pyrenae liberae per occasionem in nucem osseam coalescentes.

Erect shrub, 10–25 dm. high; no burl formation at base; bark smooth, dark red; branchlets short glandular-hairy; leaves elliptic to oblong, acute or apiculate at the apex, rounded or rarely truncate at the base, 13–35 mm. long, on petioles 4–7 mm. long, finely pubescent on both surfaces and microscopically glandular, rarely glabrate, gray green or yellowish green; nascent inflorescence (text fig. 2, d) short oblong, 10–20 mm. long, 3–8 in a cluster at the tips of the branches, closely subtended by the leaves, erect or slightly curved upwards as the buds develop, bracts leafy, lanceolate, 3–15 mm. long, glandular-hairy, green, tinged red, or yellow green; flowers white, 5–7 mm. long, on glandular–hairy pedicels; ovary glandular–hairy or sparsely glandular-hairy; berry globose, 5–8 mm. wide, very pale brown, shining, glabrous, sparsely hairy, or microscopically glandular; nutlets separate, or coalesced into a solid nut.

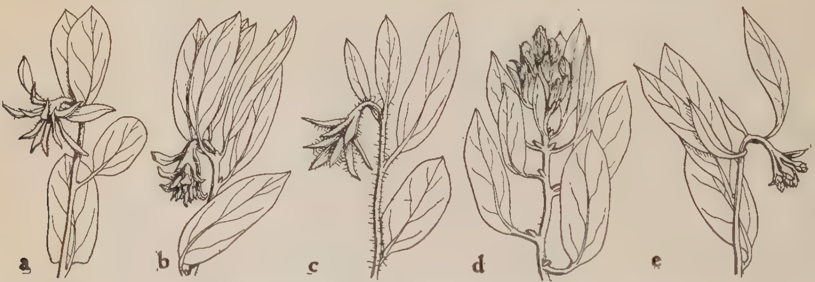
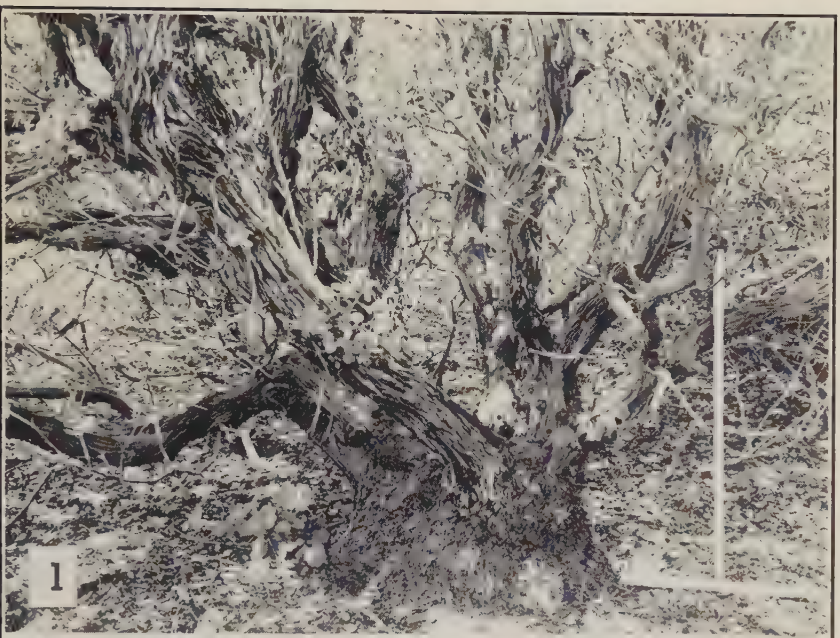


Fig. 2. Nascent inflorescences in *Arctostaphylos: a, A. morroensis; b, A. silvicola; c, A. pilosula; d, A. otayensis; e, A. rudis.*

Types. Nascent inflorescence: Otay Mountain, San Diego County, 3200 feet elevation, November 3, 1937, *H. A. Jensen 437* (VTM 22379). Flowering specimen: Otay Mountain, 3000 feet elevation, January 23, 1934, *A. E. Wieslander 350* (VTM 3476). Fruiting specimen: San Ysidro Mountains (on Otay Mountain), 1800 feet elevation, June 11, 1935, *A. E. Wieslander 552* (VTM 12510).

Distribution. In chaparral on Otay Mountain, San Diego County, 1800–3600 feet elevation, associated with *Adenostoma fasciculatum, Arctostaphylos glandulosa, Rhus laurina, Ceanothus crassifolius, Chamaebatia foliolosa* var. *australis*, and at the elevation of 1800 feet in the Tecate cypress association associated with *Arctostaphylos bicolor, A. glandulosa, Cercocarpus betuloides, Comarostaphylis diversifolia,* and *Chamaebatia foliolosa* var. *australis.*

Specimens to verify range. San Diego County: Otay Mountain, *A. E. Wieslander 351* (VTM 3277); *N. French 279* (VTM 4936).



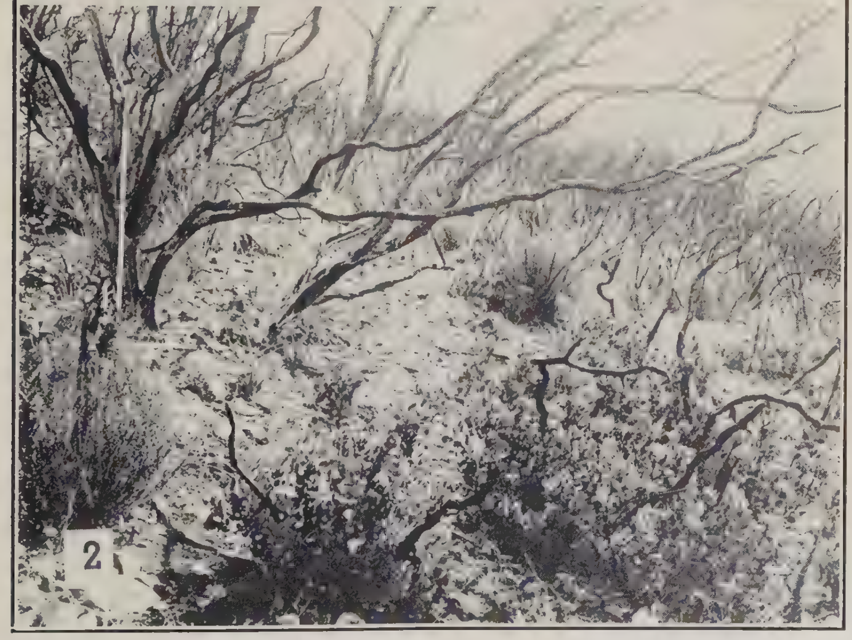


Plate 4. Burl formation and effects of fire on Arctostaphylos. Fig. 1. *Arctostaphylos rudis* showing shreddy bark and burl formation at base. Fig. 2. *Arctostaphylos glandulosa* (foreground) sprouting from burls after fire; *Arctostaphylos otayensis* (background) killed by fire.

Arctostaphylos otayensis, although resembling *A. glandulosa* in many respects, differs from that species in that no burls are formed and the plants are, therefore, killed outright by fire (pl. 4, fig. 2). The fruit of *A. otayensis* is characteristically small and very pale brown in color, shining, microscopically glandular, and usually glabrous but occasionally sparsely hairy. In *A. glandulosa* the fruits are red brown in color when ripe and usually very viscid, or glands lacking. The specific name is derived from the type locality, Otay Mountain.

ARCTOSTAPHYLOS PILOSULA sp. emend. *A. pilosula* Jepson and Wieslander, Erythea 8: 101. 1938.

Erect shrub, 10–30 dm. high; no burl formation at the base; bark dark red brown, smooth; branchlets pubescent, and with long or short bristly hairs, or these sparse, or occasionally lacking; leaves oblong, elliptic to ovate, 15–45 mm. long, on petioles 5–9 mm. long, truncate or rounded at the base, rarely subcordate, occasionally small teeth at the base, apex apiculate, or merely acute, glaucous green or yellow green, (bright green in one form from Sycamore Springs, branches then densely long hairy), glabrous, or sparsely pubescent on both surfaces, young leaves on new twigs densely silvery-tomentose; nascent inflorescence (text fig. 2, c) short, campanulate, 10–14 mm. long, 1–2- rarely 3-clustered at the tips of the branches, mostly pendulous, bracts leafy, 5–14 mm. long, lanceolate, finely pubescent to glabrous, and usually with coarse bristles but these occasionally sparse or lacking, bright green, tinged reddish, or glaucous green; flowers white, tinged pink, 4–7 mm. long, on glabrous or slightly hairy pedicels; ovary usually glabrous (except in one form from near Los Berros); berry depressed globose, 8–10 mm. wide, glabrous, orange brown or red brown, usually with blue-black vertical stripes when mature; nutlets separate.

Distribution. Chaparral areas of San Luis Obispo County, 200 to 3600 feet elevation, associated with shrubs of *Adenostoma fasciculatum, Salvia mellifera, Eriogonum fasciculatum, Lotus scoparius,* and in the La Panza range associated with *Pinus Coulteri.*

Specimens to verify range. SAN LUIS OBISPO COUNTY: Dove, *D. I. Axelrod 555* (VTM 17461); Edna, *A. E. Wieslander 646* (VTM 17234); Price Canyon, *H. C. Lee 427* (VTM 14053); Indian Knob, *H. C. Lee 392* (VTM 14019); Sycamore Springs, *A. E. Wieslander 580* (VTM 12522); Los Berros Creek, *H. C. Lee 425* (VTM 14051); Summit, *H. C. Lee 242* (VTM 15247); Porter Ranch, *C. M. Belshaw 1690* (VTM 14317); Suey Creek School, *H. C. Lee 618* (VTM 15632); Park Ranch, *H. C. Lee 578* (VTM 15593); Tar Springs Ranch, *H. C. Lee 572* (VTM 15587); New District School, *A. D. Gifford 820* (VTM 19640); American Canyon, *A. E. Wieslander 261* (VTM 2237); La Panza range, *A. E. Wieslander 538* (VTM 8434); La Panza, *W. A. Peterson 652* (VTM 19249); La Panza, *D. I. Axelrod 538* (VTM 17467); Edna, *Beryl*

Schreiber 2561 (VTM 23747); Pozo, *A. D. Gifford 800* (VTM 19625).

Arctostaphylos pilosula is one of the dominant species of manzanita in the chaparral of San Luis Obispo County. There is great variation in color of foliage, the shrubs in different areas varying from glaucous green through gray-green to the bright green form from Sycamore Springs. The amount of pubescence also varies on the shrubs in a given area. The variants are retained in the same species on other characters. One peculiarity which field men first observed and used for identifying this species was the bluish-black vertical stripes on the mature fruit. This character has been noted on all fresh fruits, and, in the dried specimens on those fruits which have not become shriveled.

ARCTOSTAPHYLOS PARRYANA Lemmon var. **pinetorum** (Rollins) comb. nov. *A. pinetorum* Rollins, Rhodora 39: 462. 1937.

Branchlets, petioles, and inflorescence densely glandular-pubescent; nutlets usually separate.

Distribution. Mountains of southern California, 5000 to 8000 feet elevation, associated with such species as *Pinus Jeffreyi, Pinus Lambertiana, Abies concolor, Quercus chrysolepis, Ceanothus cordulatus,* and *Castanopsis sempervirens;* Uinta Mountains, Utah; Uncompahgre Plateau, Colorado.

Specimens to verify range. LOS ANGELES COUNTY: Table Mountain, *Joseph Ewan 9852* (CAS). SAN BERNARDINO COUNTY: Butler Peak, *A. E. Wieslander 568* (VTM 12512); Silver Creek, *D. I. Axelrod 395* (VTM 9593); Lytle Creek, *R. St. John 167* (VTM 1658); Summit Camp Baldy, *J. S. Horton* (VTM 12263); Big Bear, *A. Lewis 124* (VTM 1659); Mill Creek, *J. S. Horton* (VTM 12264); Fawnskin Valley, *A. E. Wieslander 569* (VTM 12516); Santa Ana Cañon, *S. B. Parish 19291* (UC, D); Bluff Lake, *S. B. Parish 3708* (UC); Telegraph Peak, *I. M. Johnston 1540* (UC, D); Cucamonga Peak, *I. M. Johnston 1580* (UC, D); Jenks Lake, *P. A. Munz 12745* (UC); Dry Lake, *J. Grinnell 2* (UC); Bear Valley, *S. B. Parish,* June 1886 (UC, D); Mt. San Antonio, *LeRoy Abrams 2703* (D). RIVERSIDE COUNTY: Tahquitz Valley, *H. A. Jensen 443* (VTM 22384). In addition to the above California localities are the following: 31 miles southwest of Whitewater, Uncompahgre Plateau, Mesa County, Colorado, *Rollins 1928* (UC); Uinta Mountains, Utah (Rollins l.c. 463).

The southern California plant is identical with that described by Rollins from the Uncompahgre Plateau, Colorado. As the Californian plants of this species so closely resemble *A. Parryana* of southern California in habit and their ranges intermingle it has been found necessary to reduce *A. pinetorum* to a variety of *A. Parryana.* The distinguishing character which differentiates the two is the glandulosity of the branchlets, petioles and inflorescence of var. *pinetorum,* whereas in *A. Parryana* they are

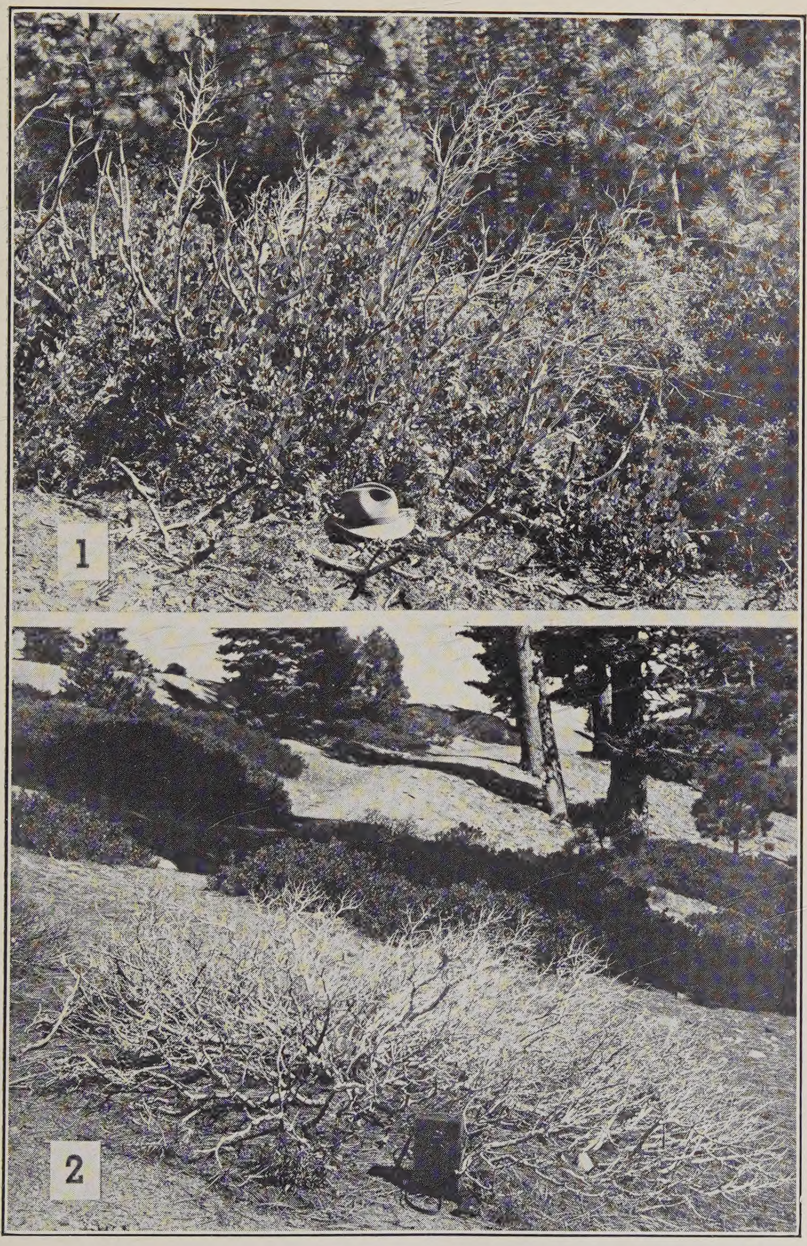


Plate 5. Effects of fire on two species of Arctostaphylos. Fig. 1. *Arctostaphylos patula* sprouting from burl after fire. Fig. 2. *Arctostaphylos Parryana* var. *pinetorum* killed after fire.

merely canescent. The nutlets in *A. Parryana* are most usually coalesced into a solid stone, while in var. *pinetorum* they are frequently separate. *A. Parryana* usually occurs between 4000 and 6000 feet elevation while var. *pinetorum* is generally found at higher altitudes although their ranges frequently overlap.

Arctostaphylos Parryana var. *pinetorum* of southern California has long been mistaken for *A. patula* Greene of the Sierra Nevada. However, *A. patula* forms a definite burl, whereas *A. Parryana* var. *pinetorum* does not. This has been carefully checked by the field crews of the Type Map Survey and in no instance was a burl found. Layering does occur and might be mistaken for sprouts from a burl. After fire *A. Parryana* var. *pinetorum* is killed (pl. 5, fig. 2), while in *A. patula* regeneration takes place by sprouting from the burl (pl. 5, fig. 1). Lack of burl formation in *A. Parryana* var. *pinetorum* was observed also by Rollins in the Colorado plants. A study of many southern California specimens both in the field and herbarium indicates that *A. patula* does not occur south of the Tehachapi Mountains.

California Forest and Range
Experiment Station, Berkeley,
November 28, 1938.

NOTES AND NEWS

The following publication should be of special value to those interested in growing native California plants: Collecting and Handling of the Seeds of California Wild Plants, by N. T. Mirov and C. J. Kraebel, California Forest and Range Experiment Station, Forest Service, United States Department of Agriculture, Forest Research Notes No. 18, p. 1–27, 1937 (multigraphed). The preliminary part of the paper deals with methods of collection, extraction and storage of native plant seed while the bulk of the text deals with germination experiments. Methods of hastening germination of refractory seeds are discussed. In the appendix seed and cultural data for some 250 California plants are summarized under the following headings: time of seed collecting; approximate number of seeds per pound; days between sowing and germination; highest germination percent obtained; treatment and cultural remarks.

PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

March 17, 1938. Meeting, Room 2093, Life Sciences Building, University of California, Berkeley, at 8:00 P. M. The president, Mr. H. E. McMinn, occupied the chair. Lecture: "Madagascar" by Mrs. Harold E. Kirby of Berkeley; illustrated by slides.

April 23, 1938. Silver Jubilee Dinner at the Berkeley

Women's City Club celebrating the twenty-fifth anniversary of the founding of the Society. Reported previously (Madroño 4: 239–240. 1938).

October 20, 1938. Meeting, Room 2093, Life Sciences Building, University of California, Berkeley, at 8:00 P. M. The president, Mr. H. E. McMinn occupied the chair. The meeting was devoted to reports on field observations during the past season, and on native plants in cultivation. Mr. McMinn turned the meeting over to Dr. Herbert L. Mason, the appointed leader of the discussion. Those taking part were: Mrs. H. P. Bracelin, specimens of unusual interest collected in South America by Ynes Mexia; Dr. Jens Clausen, exhibit of a white-flowered plant of *Zauschneria,* descended from two red-flowered California species; Mrs. H. N. Hansen, exhibit of pink-flowered specimens of *Penstemon minor;* Dr. Robert Hoover, habitat and distribution of the endemic California grasses, *Orcuttia* and *Neostapfia;* Dr. Herbert L. Mason, exhibit of specimens of the recently described *Eriogonum Blissianum, Sedella pentandra, Streptanthus callistus, Streptanthus batrachopus, Linanthus mohavensis,* also of a series of color forms derived in the second generation from a cross between *Diplacus parviflorus* and *D. puniceus.* Paintings illustrating activities of early botanical explorers (Adelbert von Chamisso and Johann Friedrich Eschscholtz, Thomas Coulter, Thaddeus Haenke) and a portrait of William H. Brewer were on exhibit.

November 17, 1938. Meeting, Room 2093, Life Sciences Building, University of California, Berkeley, at 8:00 P. M. The president, Mr. H. E. McMinn occupied the chair. Lecture: "Is there a quantitative approach to ecology?" by Dr. A. R. Davis, Department of Botany, University of California, Berkeley.

December 15, 1938. Meeting, Room 2093, Life Sciences Building, University of California, Berkeley, at 8:15 P. M. Mrs. Viola Brainerd Baird, Second Vice President, occupied the chair. Professor E. B. Babcock, chairman of the nominating committee, submitted the names of the following candidates: President, Mr. H. E. McMinn; First Vice-President, Dr. Ira L. Wiggins; Second Vice-President, Mr. Carl Wolf; Treasurer, Dr. David D. Keck; Secretary, Dr. Lincoln Constance. A motion, made and seconded to accept the report of the nominating committee, was passed unanimously. There were no nominations from the floor. After the business meeting Dr. Ira L. Wiggins led a discussion on plants particularly appropriate to the Christmas season. The following persons took part: Mr. Sidney Boyle, mistletoe, its history and folk-lore; Mr. Cary Hill, Christmas trees, antiquity, species utilized, economic aspects; Mr. Donald Nelson, *Poinsettia,* morphology of so-called "flower," introduction into cultivation; Dr. Ira L. Wiggins, slides from natural color photographs illustrating coniferous trees of Lower California and autumn colors in Atlantic coast trees and shrubs.—E. Crum, Secretary.